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Design of a Smart Security Registration Plate for Seagoing Motorized Non-Mechanical Crafts

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***Abstract* — Unauthorized and uncertified small seagoing fishing crafts are being widely used for illegal, unreported and unregulated fishing, especially in the Indian sub-continent. Nevertheless, the registration is mandatory; the display of the registration mark and its standards for the seagoing fishing craft has not been specified in detail. Now, any fraudster can mark a fake registration number quite easily on the craft and can be used for criminal activities in the coastal areas because of the effortless wipe out possibility for the present registration marks. Thus due to the lack of standardization and regulation for the display of registration number plate for the seagoing craft, identification of genuine one is very difficult. This paper proposes a typical design of a Smart Security Registration Plate (SSRP) using Radio Frequency Identification (RFID) technology to provide secure authentication of the motorized non-mechanical fishing crafts.**

Keywords— Vessel Monitoring Systems; Radio Frequency Identification (RFID);Secure registration; passive UHF; Hard tags

I. INTRODUCTION

Healthy fisheries are essential to the livelihood of a significant percentage of the overall population. The notable concern about fishery management is illegal, unreported and unregulated fishing. Unauthorised and unregistered small seagoing fishing crafts are being used for criminal activities in the coastal areas. Today, the unethical way of using vessels are rising rapidly, and cases of illegal activities such as smuggling-in of illicit articles are accumulating day by day. After the 26/11 Mumbai terrorist attack, the Govt. of India made substantial efforts to strengthen coastal security in all the maritime state, including registration of fishing vessels under merchant shipping act 1958 [1]. Though the registration certificates have been introduced to the vessels, display of such registration number plate is not adequately implemented so far. Presently the registration mark is made on the hull of the fishing craft using conventional paint [2]. Unfortunately, the wipe out possibility for the present registration marks is effortless. Hence, any fraudsters can mark the fake registration number quite easily and use the craft for illegal fishing as well as criminal activities in the coastal areas.

Fig. 1. Sea going motorized craft

Apart from this, some crooked persons are also availing government subsidized benefits like fuel through the fake registration of the said crafts. This makes Government lose millions of rupees by giving them undeserved benefits. In addition, as the registration mark is not clear even from the nearby point of view, the law enforcement authorities face great difficulties in tracing out the registration mark. Thus due to the lack of uniformity, standardization, regulation along with automation of sea-going craft registration plates, identification of genuine fishing craft is very difficult. This paper reports a typical design of Smart Security Registration Plate (SSRP) using Radio Frequency Identification (RFID) technology to provide secure authentication of the motorized non-mechanical fishing crafts. Fig. 1 shows the various types of motorized non-mechanical crafts operating in the coastal area of Kerala, India. Registration system for Motorized Mechanical Vessel (MMV) [3] and Non-Motorized Vessel (NMV) are not discussed in this paper. RFID belongs to Self-Monitoring Analysis and Reporting Technology (SMART), provides promising opportunities for the implementation of new services in vessel monitoring and secures authentication [4]. RFID is a convenient technology and easy to use in systems and is more suitable for automatic operation [5].

RFID is widely used for many years for the identification and tracking of shipping containers on cargo freighters. The core benefits are that it provides identification without requiring line of sight can be read at short to very long range and can be encoded with significant amounts of data. Though, the marine environment requires some additional facilities on RFID systems than those typically found in warehouse environment. In marine applications, systems are always exposed to moisture and corrosive agent such as salt. Apart from this, the systems are always borne with constant motions encountered at sea. These constrains have been eliminated with hardening the systems comprising the RFID and the feasibility were established for RFID in marine applications [6]. In recent years researchers have also found various application of RFID in marine environment such as monitoring sediment transportation to study the costal dynamics [7], monitoring undersea pipeline carrying oil transportation [8], navigational guidance for underwater vehicles [9], along with underwater fish tracking [10]. All these examples show the sustainability of RFID system in marine applications.

II. TECHNICAL REQUIRMENT

To formalize the technical requirement for the design of the security registration system for the sea-going vessel, a typical case study was conducted in the entire marine districts of Kerala regarding the size, shape and type of various motorized non-mechanical vessel (MNV) existing in the coastal area. It is found that there are about nine categories of crafts in operation with respect to the base material, shape, size, and type. They are thanguvallam, kattamaram, plywood canoe, fibre craft, FRP vallam, traditional canoe etc.

TABLE I.

SUB CATEGORIZATION OF MOTORIZED NON-MECHANICAL VESSELS IN KERALA REGISTERED @ 2015

Hull material		**Engine Horse Power (HP)**	
Category	***Number***	***Category***	***Number***
Wood	5530	≤10	23320
Steel	10	>10 & ≤15	864
Iron	1	>15& ≤30	3043
Fibre glass	9884	>30 & ≤45	1409
Plywood	10693	>45 & ≤90	0
Composite	3	>90 & ≤100	0
fibre	2296	>100 & ≤110	0
Wood fibre	83	>110 & ≤120	0
FRP	3	>120 & ≤130	2
		>130 & ≤140	1
		Above 140	3

Hull length (m)		**Hull breadth (m)**		**Age (year)**	
Category	***Number***	***Category***	***Number***	***Category***	***Number***
≤30	28648	Up to 10	28482	Up to 5	9084
>30 & ≤40	2			6-10	5955
>40 & ≤50	0			11-15	4618
>50 & ≤60	3	Above 10	21	Above 15	8998
Above 60	4				

Table I shows the sub-categorization of MNV with respect to the hull material, length, and breadth along with engine power and age of operation. This is one of the main constraints to design a uniform and standardized security registration system for the seagoing fishing craft. Also, the marine environment and direct contact with seawater affect the life to the system; it requires a robust protection for better lifetime i.e. minimum 4 to 5 years. Another requirement is to identify the suitable position to fix the registration system, without hampering the regular activity of the fishermen and also to prevent damage from the recurring possibility of collision between the crafts in the shore while it is not in operation. The vessels are the movable objects and sometimes in specific areas there will be a cluster of objects to be identified simultaneously. Hence, to make an automatic identification of the security system, i.e. storing and remotely retrieving data from the device, a suitable Radio-frequency identification (RFID) device called RFID tag or transponder has to be attached [11]. As the security registration plate is applied to the motorized non-mechanical vessels the availability of power source is less. During the selection of the RFID tag, the parameters also to be considered are the data rates, longer reading distances, and smaller antenna sizes, along with affordable cost. After a detailed study, the following technical requirements are identified for designing the security registration system.

- High Durability
- High Security
- High Rigidity
- Tamper Evident
- High Corrosion resistant
- High Night Visibility
- Number Legibility
- Suitable RFID Tag
- UV protection

Fig. 2. Sea going motorized craft

III. SYSTEM DESIGN

Considering the technical requirement formulated in the above section, a Smart Security Registration Plate (SSRP) system was designed. SSRP comprises of a flat board having rectangular shape made up with the marine compactable material, embedded with registration numbers for visual inspection designed with holographic, laser etched security features for protection against forgery, integrated with a RFID tag having a microchip containing complete information regarding the vessel and fisherman for the automation process. The main component of the SSRP is the security registration plate and the RFID tag. To avoid the damage due to the direct collision between the craft, the suitable position identified for fixation of security registration system is the front side of the vessel underneath to the beading as shown in Fig. 2. RFID tags have their own power source are named as active tags. Those without a power source are named as the passive tag [12]. Here, the passive RFID hard tag is selected to avoid the power requirement to operate the system as the active tag requires replaceable or rechargeable battery. In additions to this the active tag battery compartment presents additional weak point with respect to maintaining marine environmental resistance. The details of the Smart Security Registration Plate (SSRP) design components are shown in Fig 3.

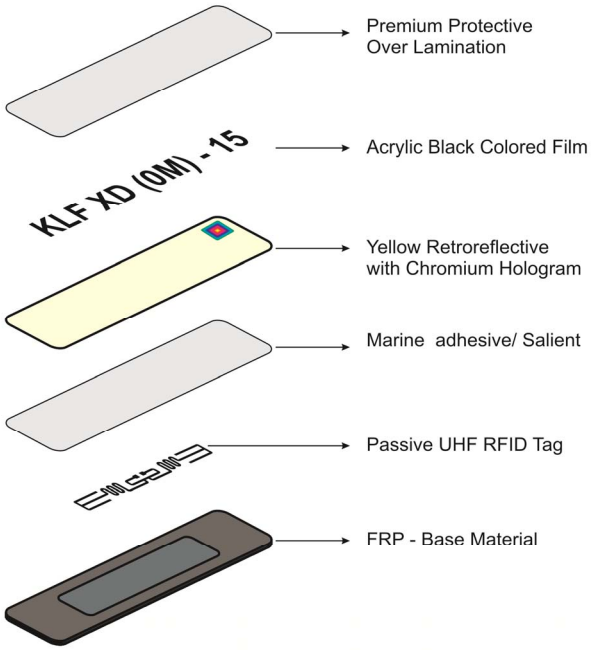

Fig.3 Components of SSRP

A. Security registration plate

It is designed with FRP material covered with reflective sheeting yellow in colour with rectangular in shape having a typical dimension of 520 mm length and 120 mm width. Yellow retroreflective sheeting is used with a high coefficient of retroreflection, visible from ~900 -1000 m distance with no metal content. It should be rigid and highly durable prismatic grade. The use of FRP lowers weight and also the proper lamination makes the plate rigid and durable. The shape of the system is designed to install the same in front side underneath of the beading of the craft. The letter and numerals are embedded with durable, acrylic black coloured film on top of the yellow retroreflective sheeting. A chromium-based hologram is embossed on the registration plate by a hot stamping process. Holograms cannot be duplicated [13]. Being hot stamped with high pressure at 220^0 Celsius, and then laminated, this hologram cannot be tampered or removed or replaced. Once the hologram embedded into the sheeting, they become an integral part of the system. The registration system is finally over laminated with premium protective overlay film. It also contains laser etched unique number for each plate which makes it possible for personalization of the registration plate. It acts as a watermark and cannot be erased. Fig 3 shows the component layers of SSRP.

B. Passive RFID system

In a passive RFID system, RFID reader transmits an RF signal to the RFID tag or transponder [14]. The tag contains an antenna and a chip. The chip activates by taking power from the antenna and reacts by adjusting the input impedance [15]. Hence, the backscattered signal could be modulated. Amplitude shift keying (ASK) is used as the modulation scheme in the corresponding system and the chip impedance switches between two states: one is matched to the antenna and another one is firmly mismatched. The most significant RFID system performance parameter in this security registration system is tag range and it is defined as the maximum distance at which RFID reader can be able to either read or write information to the tag. Tag range is calculated with respect to a certain read/write rate (percentage of successful reads/writes) which varies with a distance and depends on RFID reader characteristics and propagation environment. Passive tags do not require any onboard power source [16]. Tags are passively powered by the electromagnetic waves from the reader which restricts the computing power and limits the read and write range. The basic RFID system is shown in Fig. 4. Table II shows the comparative study of passive RFID tags. Manufacturing cost is also less for such tags and therefore, they can be applied to less expensive applications. Due to the large requirement of higher data rates, longer reading distances, and smaller antenna sizes, along with marine environment, UHF frequency band RFID systems is selected for this security registration application[17]. In general passive UHF RFID, hard tags are

used for marine applications. The advantages of passive UHF RFID in marine application is as follows

- Resistance against dust
- Resistance against chemical and mechanical stress
- Protection against harsh environments
- Designed to survive high impact or vibration
- The tags can be re-used, easily updated with new data
- These tags can be read from near contact to as far as 30+ feet away.

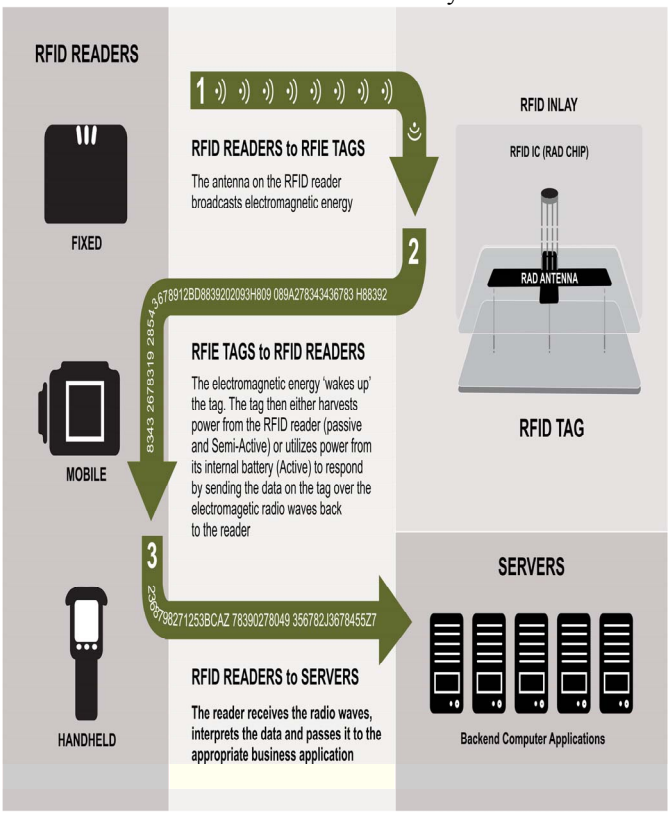

Fig. 4. Basic RFID system

From the comparative study shown in Table II, it is clear that universal asset tag is more compatible for marine based security registration application

TABLE II.
COMPARATIVE STUDY OF PASSIVE RFID TAGS

Type of tag	**Passive hard RFID tag**	**Passive UHF RFID universal asset tag**	**Portunus II tag**
Surface material	ABS	Plastic, metal, cardboard, wood	Metal
Device type	Class 1 Generation 2 passive UHF RFID transponder	EPC global UHF Class 1 Gen 2 (ISO 18000-6C)	EPC global UHF Class 1 Gen 2 (ISO 18000-6C)
Air interface protocol	EPC Global Class 1 Gen 2 (ISO 18000-6C)	EPC Global Class 1 Gen 2 (ISO 18000-6C)	UHF EPC Class 1 Gen 2
Operation frequency	860-960 MHz	915 MHz	902MHz-928 MHz
IP classification	IP67	Alien Higgs3	Alien Higgs3
Read range	Up to 5-7 m	Up to 8.4 m (27.5ft)	Up to 30 ft
Memory bits	TID 96,EPC 128, user 512,Access 32,Kill 32	EPC 96 bits, User 512,TID 64 bits	512 bit
Operating temperature	0^0F to 175^0F	-40^0C to $+70^0$F	20^0F to 200^0F
Size	102 x 22 mm	73 x 34.9 mm	101.6 x 50.8 mm

C. Tag attachment.

This RFID tag is designed to be attached to an engraved FRP based registration plate using marine compactable sealant or adhesive. In the long term, vibrations occurred in the vessels due to sea waves can cause tag attachment to loosen and eventually RFID-tag may fall off. The sealant will prevent such damages to RFID tag. Sealant or adhesive can be silicon, epoxy or any other type of sealant/adhesive- product.

D. Marine adhesive/ sealant

Marine Adhesive/Sealant is a one-part polyurethane that chemically reacts with moisture to deliver robust and flexible bonds [18]. It has very good adhesion to wood gel coat and fiberglass. It forms a watertight, weather-resistant seal to the RFID tag. Its flexibility provides dissipation of stress caused by shock, vibration, shrinking or swelling to the RFID tag. This type of product has to be stored at 60-80°F (16-27°C) for achieving the maximum storage life. The issue is that higher temperatures reduce normal storage life. Due to this lower temperatures can cause increased viscosity of temporary nature. Care has to be taken to select the sealant to provide the non-shrinking property otherwise it will affect the life of tag. It is also very important to clean all surfaces to be bonded before applying the sealant.

E. Edge sealing and tamper evident affixing

Edge sealing is an important application which minimizes the adverse effects of rigorous use or prolonged or severe exposure conditions by providing water and contaminant-tight seal between the layers of the security registration system [19]. Edge sealing improves the resistance to environmental damage and enhances the durability of the system. Epoxy Adhesives having the fast cure and machinability are the best choice for the edge sealing process. For optimum strength structural bonds, paint, oxide films, oils, dust, mould release agents and all other surface contaminants must be completely removed. The amount of surface preparation directly depends on the required bond strength and the environmental ageing resistance. The snap lock is the external fastening device with normal bolting procedure can be used for tamper evident affixing the registration plate to the vessel's body. The device prevents removal and reusability of the registration plate from the vessel. Also, any tampering with the snap lock is easily identifiable by naked eye making it easy for the law enforcing agencies to detect any abnormality in the registration plate.

IV. SSSRP FABRICATION PROCESS AND WORKFLOW

Smart Security Registration Plate (SSRP) system is designed with a passive UHF RFID hard tag embedded in fiberglass material, laminated with retroreflective sheeting displaying Government approved identification number with significant visibility. Fig. 5 shows the fabrication workflow of the smart security registration plate (SSRP).

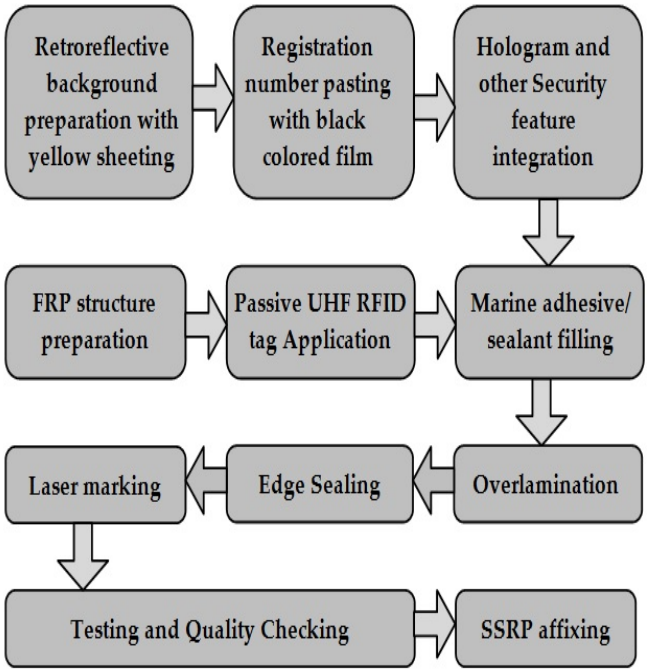

Fig. 5. Fabrication process flow

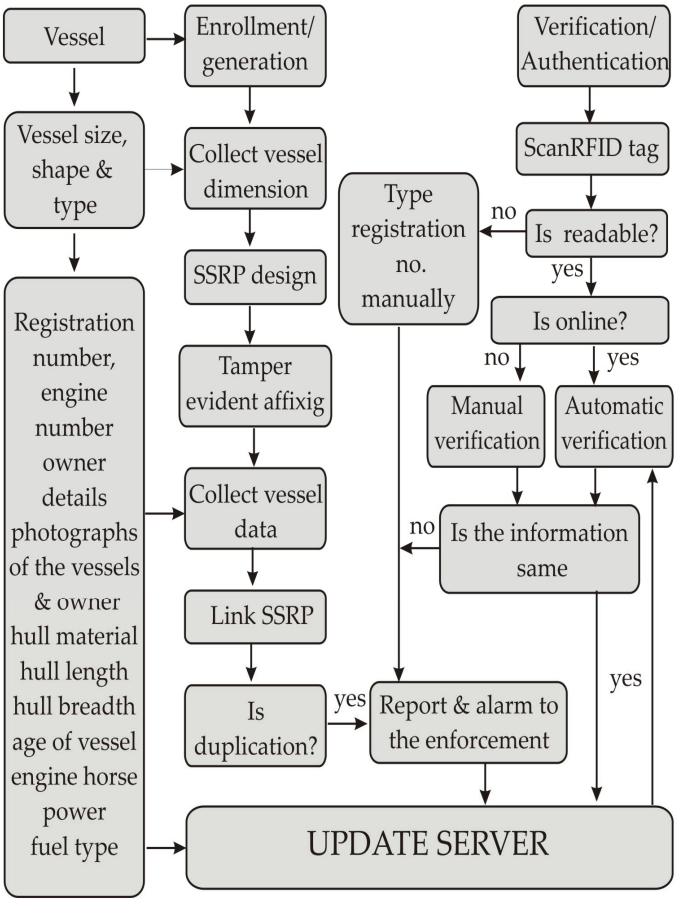

Fig. 6. SSRP based vessel enrollment and verification workflow

The basic hardware infrastructure required for the automation process such as enrollment, verification and authentication are RFID sensor/reader or handheld devices for enrollment and authentications, required PCs and online connectivity network stations/port. During enrollment, SSRP is linked with the corresponding server with vessels details such as registration number, size and shape of the vessels, engine (motor) number, owner details along with photographs of the vessels and owner etc. Fig. 6 shows the SSRP based vessel enrollment and verification workflow. Electronic data on the tag can be password protected and encrypted so that only authorized parties can read the information. In verification and authentication stage, first, scan the RFID tag and then verify either online or offline mode operation. In online mode of operation, the details can be directly collected from the server kept in the control room. Fig. 7 below shows the system workflow with closed system logistics required for the verification and authentication. SSRP transmits the data to the reader in response to the corresponding signal to the SSRP and then the reader which comprises active devices will send the information to the server in the control stations. This information can also be able to send to other port through transmission tower, so that a closed loop authentication can be provided. If it is in offline mode, the registration number and other details can be cross verified from the data collected from

the RFID tag and from the tamper evident registration display board.

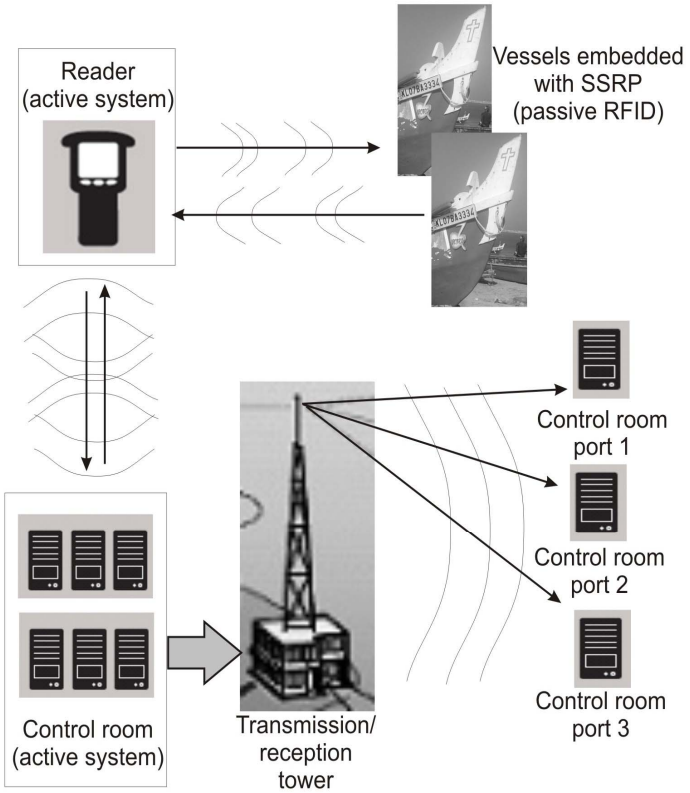

Fig. 7 Closed system logistics for the verification and authentication

V. Analysis and Discussion

Smart Security Registration Plate (SSRP) system is designed with a passive UHF RFID hard tag embedded in fiberglass material, laminated with retroreflective sheeting displaying Government approved identification number with significant visibility. SSRP system contains

1. **Security features like**
   - Security hologram
   - Laser watermarking
   - Country/state code
   - National/State emblem
   - Specific font
   - Retro-reflectivity

   → Protection against Forgery

2. **Automation systems**
   - UHF RFID hard tag
   - Microchip
   - RFID scanner/reader
   - Handheld mobile device
   - online connectivity
   - networked stations
   - Central Monitoring System

   → Provides easy Tracking

3. **Flat rectangular shape**
   - Flat onboard design - *(Wind resistance)*
   - Fiber Glass material- *(Corrosion resistance)*
   - UV-protected - *(Fade resistance)*
   - Acrylic film for numbering - *(Wipe out resistance)*
   - Visibility during night

   → Provides long life

In SSRP system, though the suitable position is identified for fixation of security registration system as the front side of the vessel underneath the beading, a typical plate size of the SSRP could not be finalized because of various dimensions of vessels as shown in the Fig. 7 are operating in the maritime region. In order to design the various size SSRP, the type of vessels has to be classified specifically and it is not under the scope of this paper.

In this design of SSRP, the letter and numerals are embedded using durable, acrylic black colored film on top of the yellow retroreflective sheeting. This will improve the visibility, particularly during the night as well as in the foggy condition. It also prevents the wipeout possibility of the registration marks and duplication of the same for the criminal activities. The hologram on registration plate is easily visible to the naked eye so that they give a direct hit about possible fraud if they are missing or destroyed/tampered with. Further, the yellow background is chosen as these colors exhibit maximum reflectance and the black letters on this background present maximum contrast in the long vision. Even though the over lamination makes it possible to withstand the inclemency of the weather for many years, the marine environment and also direct contact of seawater may affect the life of the system

Fig. 7. Various dimensions of vessels

Vessel monitoring systems (VMS) are used in commercial fishing to allow environmentally and fisheries regulatory organizations to monitor, the position, time at a position, and course and speed of fishing vessels. The Vessel Monitoring System (VMS) is basically an onboard transponder that

provides vessel identification and position via satellite communications. The limitation of such system is that the cost of the equipment is very high and it requires sufficient power to operate.

RFID, a non-contact technology which identifies objects attached with tags is applicable to various areas such as distribution, circulation, transportation, and tracking etc. [20]. RFID can also identify mobile objects of high speed and it can identify a certain amount of Tags simultaneously by its anti-collision mechanism [21, 22]. Also, it does not require contact or line of site to operate. Hence, this SSRP system can be effectively used for the distribution, track and manage any benefits such as subsidized fuel to the vessel by the government institutions. RFID is an upcoming technology which is more advantageous than data hiding technologies like a barcode. RFID systems are already used for a large number of applications related to object identification. But, there remain still a number of issues to be resolved: the multiple standards and specifications need to be further analyzed. Major issues related to tag orientation; reader coordination and the relatively short range are needed to be resolved.

VI. CONCLUSION

To design an efficient system that satisfies all the requirements with limited resources is a challenge. This approach is an attempt to make standardization along with automation in the display of registration system for the sea-going MNV to prevent illegal and criminal activity and to protect the coast. Smart Security Registration plate (SSRP) using RFID tag is designed here to provide secure authentication and effective distribution of the government benefits. A detailed study has been carried out for the design and development of SSRP system. Tag identification has been tested successfully. It eliminates duplication/multiple entries of registration for the sea going fishing crafts. It also enhances the effective accountability and easier administration for the government. It improves the security and to assist the law enforcing authorities in tracking sea going vessels.

REFERENCES

[1] K.R Sing, Coastal Security, Maritime dimensions of India homeland security, Vij Book, India, 2012

[2] http://www.dgshipping.gov.in/Content/PageUrl.aspx?page_name=ShipManualChap9.

[3] Sajan Ambadiyil, V. P. Mahadevan Pillai, V. Praveen, K. G. Jayan, S. K. Sudheer. “Holographic Registration Plates with GPRS (HRPG) network for sea-going vessels to augment the coastal security”. Proceedings of the International Conference on Ultra Modern Telecommunications, ICUMT 2009, 12-14 October 2009.

[4] H. Stockman, “Communication by Means of Reflected Power”, Proceedings of the IRE, pp. 1196–1204, October 1948.

[5] J. Landt, “Shrouds of Time: The history of RFID", AIM, Inc.2001

[6] Erick C. Jones, Christopher A. Chung, RFID in Logistics: A Practical Introduction, CRC Press, 2007

[7] Miller I M, Warrick JA, Morgon C, “Observations of coarse sediment movements on the mixed beach of the Elwha Delta”, Washington, Mar, Geo, 2011, 201-214.

[8] Collin J, Taking RFID at new depths, RFID Journal, Available at http://www.rfidjournal.com, 2006.

[9] Harasti T J, Howell J E, Hertel N M, “Underwater RFID arrangement for optimizing underwater operations”, US patent application publication, 2011.

[10] Bacheldor B, A fishe tale, RFID Journal Available at http://www.rfidjournal.com, 2011.

[11] S. Y. Lee, L. H. Wang and Q. Fang, "A Low-Power RFID Integrated Circuits for Intelligent Healthcare Systems," in IEEE Transactions on Information Technology in Biomedicine, vol. 14, no. 6, pp. 1387-1396, Nov. 2010.

[12] Frank Siegemund and Christian Fl¨orkemeier, “Interaction in Pervasive Computing Settings using Bluetooth-Enabled Active Tags and Passive RFID Technology together with Mobile Phones”, Proceedings of the First IEEE International Conference on Pervasive Computing and Communications, vol.1, no.3, 2003

[13] R.L. van Renesse, Protection of High Security Documents - Developments in holography to secure the future market and serve the public, Holopack.Holoprint 2006, Vienna, Austria, 15 - 17 November 2006.R.L. van Renesse, Holopack. Holoprint, Austria, 2006.

[14] Cardullo et al., "Transponder apparatus and system”, U.S. Patent 3,713,148, 1973.

[15] Y. Tikhov, “Comments on ‘Antenna design for UHF RFID tags: A review and a practical application’,” IEEE Trans. Antennas Propag., vol. 54, p. 1906, Jun. 2006.

[16] Z. Min et al., “A RFID-based Material Tracking Information System”, Proceedings of the IEEE International Conference on Automation and Logistics, Jinan, China, pp. 2922 – 2926, 2007.

[17] C. C. Song et al., “Study and implementation of a networking information platform for RFID system”, IEEE International Conference on Industrial Technology, ICIT 2008, pp. 1-6, 2008.

[18] http://www.boatersworld.com/product/MP80820899msk.htm

[19] http://multimedia.3m.com/mws/media/114158O/edge-sealer-3950-4150s-and-edge-sealer-tape-8914.pdf

[20] Q. Xiao, C. Boulet, and T. Gibbons, “RFID Security Issues in Military Supply Chains”, The Second International Conference on Availability, Reliability and Security, 2007, ARES 2007, pp. 599 - 605 , 2007.

[21] T. Datta et al., "RFID based Airport Logistics Management", 3rd Innovative Conference on Embedded Systems, Mobile Communication & Computing (ICEMC2 2008), Infosys Mysore, Karnataka, India, pp. 228-232, 2008.

[22] M. T. Lockman, A. Selamat, “Multi-Agent Verification and Validation for RFID System Architecture”, International Conference on Electronic Design, Penang, Malaysia, pp.1-5, 2008.