NOVASAR AIS DATA PRODUCT POST-PROCESSING AND VISUALIZATION

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Abstract: Synthetic Aperture Radar (SAR) satellites with Automatic Identification System (AIS) has capability to provide better monitoring services to the Maritime traffic/fishing activities which have accelerated considerably over the last decade, with an impact on the marine environment and its resources. Satellite AIS(S-AIS) is a communication tracking system which utilizes transceivers on ships that exchanges information (e.g., the ship's identity, type, dimensions, position, speed, etc.) between ships and coastal stations via satellites, thereby extending its surveillance capability of onshore and offshore vessel tracking.

NovaSAR-S is a small SAR mission designed for low cost programmes using latest commercial off-the-shelf technologies developed by Surrey Satellite Technology, Ltd. (SSTL). NovaSAR-S launched on 18th September 2018 has also carried an additional AIS receiver which, when used to collect data with SAR imagery of the same area and will provide additional information on the identification of legal ships and highlight non-AIS transmitting vessels located in restricted areas. The AIS data logged at ISRO Ground Station is processed by SSTL and are mostly susceptible to errors originating from AIS transmitters, onboard AIS receiver problems and finally in formatting of the AIS data. AIS receivers can be easily spoofed using wrong signals either received by GPS spoofing or an erroneous transmission of AIS message. Other sources of error include loss of acquisition over an area. There are cases when the date/time information is corrupted by the onboard AIS processor. This loss of robustness in the algorithm/system design is not the sole cause of problem; the huge volume of data acquired creates another set of problem that need to be addressed. All the required information is encoded in NMEA AIVDM format, which is decoded by the AIS processor of SSTL and the data product denotes typical AIS messages. In this paper, we discuss about the bottlenecks encountered in S-AIS data products, mitigation approaches adopted for retrieving correct AIS messages and visualization of position/track of ships.

NovaSAR AIS data product contains .csv file with all the fields processed in AIS receiver and a comprehensive xml file which houses the original AIVDM raw sentence alongside the decoded fields. For a single day, the AIS data amounts to approximately 0.1 million unique packets of AIS messages, this huge amount of data/messages from AIS

transmitters can be classified into 27 different types of messages out of which two categories are primarily position update and trip status/update. Each AIS packet corresponding to a ship which is identified by a unique Maritime Mobile Service Identity (MMSI), and the following relevant fields/parameters received are noteworthy: MMSI, Navigation Status, Rate of Turn, Speed over Ground, Position Accuracy, Longitude, Latitude, Course over Ground, True Heading, Timestamp, Maneuver indicator & Radio Status etc., The outputs generated from the same are to be filtered properly to visualize global view of all the acquired MMSIs.

Figure 1(a) and (b) represents the plot of single ship (Ex: MMSI: 635030000) and all ship positions as received after dropping duplicate messages in AIS packets. Even then, Roll over effect at edges of the map is observed for few ships wherever Lat-Lon discontinuities are present in AIS data. This is a serious problem which needs to be addressed and rectified so as to obtain the correct path of the ships. Various strategies to prune the erroneous AIS packets like Format based, Absolute Value based and Feasibility based approaches are implemented. All the above approaches are implemented in Python. In Format Based Filtering, the corrupted records are filtered out based on standard AIVDM format compatibility. In Absolute Based Filtering, AIS messages having positional values (Lat/lon) out of their principal values are filtered along with messages originating out of the footprint of NovaSAR. In Feasibility Based Filtering Approach, the track of each ship of corresponding MMSI is derived from the AIS message, and rule out the ships covering unrealistic distances in short span of time based on the speed, rate of turn, position etc., from which decision making module is invoked to identify whether the vessel is deemed fit or unfit for use. After performing these filtering approaches on each AIS packet corresponding to each MMSI, then correct position of ship can be identified as shown in Figure 1(c) without any Lat/lon discontinuities. Upon Analysis, after discarding/scraping data from ill formatted files, the average number of unique AIS messages received per day is significantly less than all received AIS messages. Study has also been extended for throttling down the data volumes using the Adaptive Resampling technique which provides efficiently data storage without losing essential information.

Conclusion: The AIS messages along with AIVDM format is understood for NovaSAR-AIS data where all the parameters are retrieved. As AIS receivers can be easily spoofed using wrong signals either received by GPS spoofing or an erroneous transmission of AIS message, which demands appropriate filtering operations for correct retrieval of parameters and hence its further association with maritime SAR data. This data when fused with other AIS sources can also improve the tracking capability of a given vessel. In this paper, we made an attempt to successfully extract AIVDM packets, implementation of various filtering approaches to remove duplicates, roll over affects at edges, ships covering unrealistic distances etc. The approach is deemed very apt for better utilization of Ship information and detection of rogue ships. Nevertheless, unrealistic ship location on landmasses can be handled by overlaying land mask vector layers. The current work will aid ocean surveillance users to visualize the track and

position of shipping vessels using NovaSAR AIS data and further to appropriate decision making for mitigating marine environmental impact.

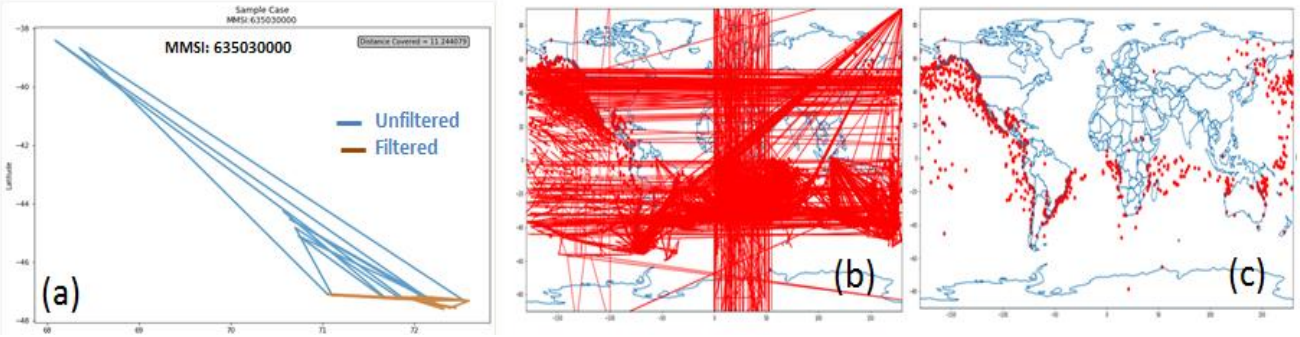

Figure 1: (a) Plot of single ship positions (b) Plot of all ships positions (c) Plot representing all ship locations after removing duplicates and applying filtering approaches.

Keywords: Automatic Identification System; Synthetic Aperture Radar; NovaSAR; AIVDM packet.