Design and Overview of Oceanic Aircraft Communications

تصميم و نظرة عامة للاتصال بين الطائرات في المحيطات

A Research Submitted in Partial fulfilment for the Requirements of the Degree of B.Sc. (Honours) in Electronics Engineering

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بنَّي فِي خَلْقِ السَّمَاوَاتِ وَالْأَرْضِ وَضَخَّطَ اللَّيْلَ وَالْنَّهَارَ وَالْفَلَقَ الَّتِي تَجْرِي بِالنَّارِ بِمَا يَنْفَعُ النَّاسَ وَمَا نَرَى إِلَّا مِنْ عِلْمِ اللَّهِ مِنْ السَّمَاءِ مِنْ مَاءٍ قَاَخْتَاهِ إِلَّا أَرْضٌ تَعْدُ مَوْتِهَا وَبَثْنَ فِيهَا مِنْ كُلِّ ذِبَابٍ وَذُجُّفْنَ الرَّيْحَ وَالسَّحَاتُ إِنَّ فِي ذَٰلِكَ مِنْ عِلْمِ اللَّهِ مَا ثُقُلٌ فَهَلْ تَعْلَمُونَ

البقرة: 164
DEDICATION

You held my hand to steady me
Till I was ready to make a stand
On my own two feet
You were there to show me
How to truly believe
In the miracle of creation
In the good and the bad
When my head was down you prayed for me

To my caring parents Aldaw Ali & Awatif Ahmed,
Beloved sisters Nisreen, Shaza, Shireen, Alaa &
Eman and to my beautiful nieces Leen & Tala
I dedicate this humble work.
Praise be to Allah whom all people praise in different languages. He is the Most Bounteous and the Most Beneficent. I praise and thank his uncountable Gifts.

I would like to express my sincere gratitude to my advisor Dr. Ashraf Gasim Alseed for his continuous support of my research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

Though only my name appears on the cover of this thesis, a great many people have contributed to its production. I owe my gratitude to all those people who have made this research possible and because of whom my graduate experience has been one that I will cherish forever. Special thank goes to my best friend and companion Maram Elfatih. Also I would like to express my deep and sincere gratitude to all my teachers at Sudan University of science and technology.
Every day the sky carries about 8 million people flew on nearly 100,000 flights, thus it is very important to coordinate the movement of air traffic to make airplanes stay a safe distance apart in order to avoid collision, and keep an eye on aircraft during its flight time. The limitation of conventional radar technology, relatively low accuracy and the fact that radars are only placed on land, make it difficult or even impossible to track airplanes when they are flying over oceans. The main objective of this research is to highlight surveillance technologies and give a simplified method to track aircrafts in non radar areas, simple scenarios were simulated using system tool kit software which is a tool designed for simulating airspace, 25 aircrafts paths were selected from 2524 real routes and modeled with simple link budget calculation.
المستخلص

السفر بالطيران غير مسار العالم تماماً، وسهل على الناس السفر حيث أتاح امكانيه الاتصال حول العالم بكل سهولة ويسر و في فترات زمنية قصيرة. كل يوم تشهد السياحة حوالي 100 ألف رحلة جوية تتحمل حوالي 8 مليون نسمة، لذلك من المهم تنظيم حركة الطائرات لتبني في حدود مسافة معقولة منها للتصادم ولاجراءات السلامة، قصور وأعمال ضبط الرادار التقليدية وحقيقة أن الرادارات تنشأ على اليابسة فقط. تعصب عملية تتبع الطائرات عندما تحلق فوق المحيطات الشاسعة. الهدف الأساسي من هذا البحث هو تسهيل الضوء على امكانيه الراقبة والاستطلاع المستخدمة من قبل الراقبة الجوية، وأعطاء مفهوم مبسط لنتائج الطائرات عبر المحيطات حيث لا توجد نقطة بأجسام الرادار. أيضاً تم محاكاة التصميم المفترض باستخدام برنامج مجموعة أدوات النظام، وهو برنامج مصمم خصيصاً لمحاكاة الفضاء. 25 مسار من أصل 2524 مسار حقيقي للطائرات اختيار لتيسير المحاكاة، كما تم حساب مؤشرات جودة الرابط المفترض.
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ABBREVIATION

AANET Aeronautical Ad hoc NETwork
ACC  Area Control Center
ADS-B  Automatic Dependent Surveillance Broadcast
AeroRP  Aeronautical Routing Protocol
AMM  Aircraft Mission Modeler
ASN  Aviation Safety Network
ATC  Air Traffic Control
ATM  Air Traffic Management
AWOS  Automatic Weather Observing Station
CDTI  Cockpit Display of Traffic Information
FAA  Federal Administration for Aviation
FCM  Fuzzy C Means
FIS-B  Flight Information Service Broadcast
GLSR  Geographic Load Sharing Routing
GNSS  Global Navigation Satellite System
GPS  Global Positioning System
GPSR  Geographical Position-Based Routing
GRAA  Geographic Routing protocol for Aircraft Ad hoc
<table>
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<tr>
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<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HAP</td>
<td>Higher Altitude Platform</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<tr>
<td>LOS</td>
<td>Line Of Sight</td>
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<tr>
<td>MANET</td>
<td>Mobile Ad hoc NETwork</td>
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<tr>
<td>MFD</td>
<td>Multi-Function Displaying</td>
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<tr>
<td>NAS</td>
<td>National Airspace System</td>
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<tr>
<td>NATs</td>
<td>North Atlantic Tracks</td>
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<tr>
<td>OTS</td>
<td>Organized Track System</td>
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<tr>
<td>PSR</td>
<td>Primary Surveillance Radar</td>
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<tr>
<td>RADAR</td>
<td>RAdio Detection And Ranging</td>
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<tr>
<td>RCS</td>
<td>Radar Cross Section</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<tr>
<td>RGR</td>
<td>Reactive Greedy Reactive</td>
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<tr>
<td>SNR</td>
<td>Signal to Noise Ratio</td>
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<tr>
<td>SSR</td>
<td>Secondary Surveillance Radar</td>
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<tr>
<td>STK</td>
<td>System Tool Kit</td>
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<tr>
<td>TCAS</td>
<td>Traffic Collision Alerting and Avoidance</td>
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<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol</td>
</tr>
<tr>
<td>TDMA</td>
<td>Time Division Multiple Access</td>
</tr>
<tr>
<td>TDOA</td>
<td>Time Difference Of Arrival</td>
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<td>TIS-B</td>
<td>Traffic Information Service Broadcast</td>
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<td>UAANET</td>
<td>Unmanned Aeronautical Ad hoc NETwork</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>--------</td>
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<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
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<tr>
<td>USPR</td>
<td>Universal Software Radio Peripheral</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
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<tr>
<td>WAM</td>
<td>Wide Area Multilateration</td>
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