



UNIVERSITI PUTRA MALAYSIA

***A NOVEL HIGH-PRECISION GROUND-BASED AIRCRAFT
LANDING SYSTEM CAPITALIZING ON TOWERS TRILATERATION***

AHMAD ABBAS AL-AMEEN SALIH

FK 2013 23



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By

AHMAD ABBAS AL-AMEEN SALIH

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment
of the Requirement for the Degree of Master of Science**

December 2013

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DEDICATION

To my parents for their endless love, support and encouragement...

الى من قال فيهما الله تعالى :

(وَقَضَىٰ رَبُّكَ أَلَّا تَعْبُدُوا إِلَّا إِيَّاهُ وَبِالْوَالِدَيْنِ إِحْسَانًا . إِمَّا يَنْبَغَنَّ عِنْدَكَ الْكِبَرَ أَحَدُهُمَا أَوْ كِلَاهُمَا فَلَا تَقُلْ لَهُمَا أُفٍّ وَلَا تَنْهَرْهُمَا وَقُلْ لَهُمَا قَوْلًا كَرِيمًا . وَاخْفِضْ لَهُمَا جَنَاحَ الذُّلِّ مِنَ الرَّحْمَةِ وَقُلْ رَبِّ ارْحَمْهُمَا كَمَا رَبَّيَانِي صَغِيرًا)

To who made a man out of me capable to face and defeat crises, show and guide me through the way ... my brother

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

**A NOVEL HIGH PRECISION GROUND-BASED AIRCRAFT LANDING
SYSTEM CAPITALIZING ON TOWERS TRILATERATION**

**BY
AHMAD ABBAS AL-AMEEN SALIH**

December 2014

Chairman: Md. Amzari Md. Zhahir, PhD

Faculty: Engineering

The rapid increase in aviation industry requires parallel effective plans, programs and designs of systems and facilities nationwide to fulfill the increasing needs for safe air transportation. Aircraft landing remains a problem for a long time all over the world. Systems that aircrafts rely on in landing are unreliable to perform a precise guidance due to many limitations such as inaccuracy, unreliability and dependency. In low visibility conditions, when pilots are unable to see the runway, the aircrafts are diverted to another airport. However, low visibility can also affect all airports in the vicinity, forcing aircrafts to land in low visibility conditions depending on Instrument Flight Rules (IFR). Aircraft approach and landing are the most hazardous portions of flight; accidents records indicate that, approximately 50 percent of the accidents occur during aircraft landing. International Civil Aviation Organization (ICAO) has divided landing systems into three categories according to decision height, visibility and runway visual range. Category IIIB is currently the best available system. It requires a runway visual range not less than 50 meter. Category IIIC is not yet in operation anywhere in the world. It requires landing in zero visibility. Nevertheless, the accuracy of existing aircraft landing systems has not been able to match ICAO required standards for landing blindly in bad weather conditions.

Air navigation involves the processes of monitoring and controlling the movement of aircraft from takeoff to landing. Currently, Global Positioning System (GPS) is the main navigation system used all over the world for aircraft navigation, approach and landing. However, in aircraft approach and landing phase, the accuracy of GPS is not sufficient to perform a perfect landing due to the possibility of aircraft to be drifted out of the runway. The accuracy of GPS could be improved by sending correction messages from ground and satellite based stations. However, improved accuracy has not been able to meet ICAO standards for blind landing. In this thesis, aircraft landing systems characteristics, performances and accuracies have been studied and compared for the purpose of assessing limitations and drawbacks. A Ground-based Aircraft Landing System capitalizing on concept of trilateration has been proposed to meet ICAO standards for all-weather to perform aircraft precision approach and landing. System specifications have been calculated, designed and then simulated using MATLAB. A simulated design has been performed using MATLAB Simulink to simulate transmission and reception of data for accurate aircraft positioning and precise guidance

to runway touch point. Aircraft positioning simulations have been performed comparing the proposed system accuracy with current aircraft landing systems. The accuracy of the proposed system has been found equipment dependent. It was calculated for different equipment specifications and was found in sub-meter level. A further accuracy improvement could be obtained by the use of better equipment performance in mitigating multipath and receiver noise. In conclusion, this system provides a solution for aircraft landing in all-weather and low visibility conditions with high precision guidance.

For an easy access and simple indication of aircraft approaching the runway, ILS style indicator has been attached to indicate the aircraft position with respect to reference path and runway touch point. The indicator has been simulated using VisualBasic.net to provide an accurate aircraft deviation from recommended route points coordinates enhancing the aircraft to land in all weather conditions regardless of level of visibility and runway visual range. The calculation and simulation of system performance demonstrated the feasibility of the system to blindly guide the aircraft to runway touch point with high precision in all-weather conditions.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia dalam memenuhi keperluan ijazah Master Sains

**SATU KEBAHARUAN SISTEM PENDARATAN PESAWAT BERASASKAN
DARATAN BERKEJITUAN TINGGI BERMODALKAN PENIGASEGIAN
MENARA**

**OLEH
AHMAD ABBAS AL-AMEEN SALIH**

Disember 2013

Pengerusi: Md. Amzari Md. Zhahir, PhD

Fakulti: Kejuruteraan

Peningkatan mendadak dalam industri penerbangan memerlukan perancangan yang berkesan, program dan rekabentuk sistem, dan kemudahan seluruh negara, dilaksanakan berselari, untuk memenuhi keperluan pengangkutan udara dengan selamat. Pendaratan pesawat masih merupakan satu masalah yang lama di seluruh dunia. Sistem pesawat bergantung pada pendaratan tidak boleh harap untuk melaksanakan satu panduan jitu kerana banyak keterbatasan seperti ketidaktepatan, ketidakboleharap dan kebergantungan. Dalam keadaan penglihatan rendah, apabila juruterbang tidak boleh melihat landasan terbang, pesawat akan dilencongkan ke lapangan terbang yang lain. Walau bagaimanapun, penglihatan rendah boleh juga menjejaskan semua lapangan terbang yang berhampiran, memaksa pesawat untuk mendarat dalam keadaan penglihatan rendah bergantung pada Peraturan Penerbangan Alatan (Instrument Flight Rules (IFR)). Sua dan pendaratan pesawat adalah bahagian yang paling berbahaya dalam penerbangan, rekod kemalangan menunjukkan bahawa anggaran 50 peratus dari kemalangan berlaku semasa pendaratan pesawat. Pertubuhan Penerbangan Awam Antarabangsa (International Civil Aviation Organization (ICAO)) telah membahagikan pendaratan kepada tiga kategori mengikut tinggi keputusan, penglihatan dan julat nampak landasan. Kategori IIIB, buat masa ini, adalah sistem yang terbaik sedia ada. Ianya memerlukan satu julat nampak landasan tidak kurang dari 50 meter. Kategori IIIC belum lagi dalam operasi di mana-mana tempat dalam dunia ini. Ia memerlukan pendaratan dengan tanpa penglihatan. Namun begitu, ketepatan sistem penerbangan pesawat ang sedia ada tidak dapat menandingi piawaian yang diperlukan oleh ICAO untuk pendaratan tanpa penglihatan dalam keadaan cuaca buruk.

Pandu arah udara melibatkan proses pemantauan dan kawalan pergerakan pesawat dari perlepasan sehingga pendaratan. Ketika ini, Sistem Kedudukan Sejagat (*Global Positioning System* atau GPS) adalah sistem pandu arah utama yang digunakan di seluruh dunia untuk pandu arah, sua dan pendaratan pesawat. Walau bagaimanapun, dalam fasa sua dan pendaratan pesawat, ketepatan GPS tidak mencukupi untuk melaksanakan pendaratan sempurna kerana adanya kemungkinan pesawat akan terhanyut keluar dari landasan. Ketepatan GPS boleh ditambahbaik dengan menghantar mesej pembetulan dari stesen asas-darat atau asas-satelit. Namun begitu, ketepatan yang ditambahbaik belum memenuhi piawaian ICAO untuk pendaratan tanpa penglihatan. Dalam tesis ini, ciri-ciri sistem pendaratan pesawat, prestasi dan ketepatan telah dikaji

dan dibandingkan untuk tujuan menilai pembatasan dan kelemahan. Sebuah sistem pendaratan pesawat berasaskan daratan bermaksud konsep penigasegian dicadangkan untuk mencapai piawai ICAO untuk pelbagai cuaca untuk melaksanakan sua jitu dan pendaratan pesawat. Spesifikasi sistem telah dihitung, direkabentuk dan disimulasi menggunakan MATLAB. Satu rekabentuk simulasi telah dilaksanakan menggunakan MATLAB Simulink yang simulat penghantaran dan penerimaan data untuk ketepatan kedudukan pesawat dan kejituan pandu arah kepada titik temu landasan. Simulasi kedudukan pesawat telah dilaksanakan dengan membandingkan ketepatan sistem dengan sistem pendaratan pesawat semasa. Ketepatan sistem yang dicadangkan didapati bergantung pada peralatan. Ia telah dihitung untuk spesifikasi peralatan yang berbeza dan didapati dalam aras sub-meter. Satu penambahbaikan ketepatan lanjut boleh didapati dengan menggunakan peralatan berprestasi lebih baik dalam mengurangkan pelbagai-laluan dan hingar penerima. Rumusnya, sistem ini menyediakan satu penyelesaian untuk pendaratan pesawat dalam semua cuaca dan keadaan penglihatan rendah dengan pandu arah berkejituan tinggi.

Untuk capaian mudah dan penunjuk mudah sebuah pesawat menyua landasan, penunjuk gaya ILS dikepilkan untuk menunjukkan kedudukan pesawat merujuk kepada laluan dan titik temu landasan. Penunjuk telah disimulat menggunakan VisualBasic.net untuk menyediakan ketepatan sisihan pesawat dari koordinat titik laluan meningkatkan pesawat untuk mendarat dalam keadaan segala cuaca tanpa aras penglihatan dan julat nampak landasan. Penghitungan dan simulasi prestasi sistem menunjukkan kebolehlaksanaan sistem untuk memandu pesawat tanpa penglihatan ke titik temu landasan dengan kejituan tinggi dalam keadaan semua cuaca.

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To my friends: thanks a lot for your support and encouragement and for keeping my heart full of ambition to go on until the end of the road. Thanks a lot for believing on me.

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To who played important roles along the journey, you will always be in my mind and may Allah gather us again in aljannah.



Approval

I certify that a Thesis Examination Committee has met on **December 20th, 2013** to conduct the final examination of **Ahmad Abbas Al-Ameen Salih** on his thesis entitled "**A NOVEL HIGH-PRECISION GROUND-BASED AIRCRAFT LANDING SYSTEM CAPITALIZING ON TOWERS TRILATERATION**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Harijono Djojodihardjo, PhD

(PROF. IR. DR.)

Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Harlisya Harun, PhD

Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Suhaidi B. Shafie, PhD

Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Abdul Aziz Jaafar, PhD

Associate Professor
Faculty of Manufacturing Engineering
University Malaysia Pahang
(External Examiner)

NORITAH OMAR, PhD

Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 17 February 2014

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of Supervisory Committee were as follows:

Md. Amzari Md. Zhahir
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Mohamed Tarmizi bin Ahmad
Associate Professor Lt. Col. (R)
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Mohd Ramly Mohd Ajir
Associate Professor Lt. Col. (R)
Faculty of Engineering
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: December 2013

DECLARATION

Declaration by graduate student

I hereby confirm that:

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