

MODEL PREDICTIVE CONTROL FOR UAV SURVEILLANCE

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Abstract: Recent advancements in processing capabilities have enabled the use of new computationally costly control methods like the Model Predictive Control on real-time applications. We describe the application of model predictive control using state mapping to the automatic landing system of a space plane. The controller has to be designed to enable the vehicle to follow reference signals with respect to trajectory and velocity. To track the reference signals, a control input is generally designed so that one or more ideal transient responses are realized. We also have developed a flight control system based on this concept. There is large time delay in 'man-in-the loop' unmanned aircraft vehicle system, especially for remote control flight by satellite communication. Current autopilots have limitation, as they may encounter situations where 3-D positioning information is lost or unavailable. The pilot will operate in a pseudo open-loop format by generating flight control signals based on time alone. It allows running independent of path data and positioning information.

Keywords: MATLAB, Model Predictive Control, UAV

automation there are many challenges involved in it one of the main challenges is the landing of UAVs. The problem in landing is because they are very crucial, minor error in the landing will prove to be fatal moreover the data required for landing should be highly precise and accurate.

One of the major landing problems involves the detection of the surface where they are going to land the UAV. To overcome this challenge the type of terrain needs to be chosen automatically and needs to be informed to the controller periodically when asked for the landing. The framework is designed for supervising MPC to be implemented over a simpler, more reliable internal loop PID Autopilot without making any modifications to its structure. The proposed system is able to add new capabilities to the internal loop by making little corrections to its control demands, ensuring that the compliance with restrictions. At the end, the system was able to ensure safe landing over many critical conditions by effectively expanding the internal autopilots states and enforcing the altitude restrictions. We describe the application of model predictive control using state mapping to the automatic landing system of a space plane.

1. Introduction

UAV popularly called as drones is one of the important inventions in the modern era. These machines are particularly useful in modern warfare where they are reducing many lives by decreasing the number of personnel involved in the air bombing. UAVs are not confined only to warfare they are also used in many applications such as maintenance in wind turbines, aerial photography, surveillance, etc. Now UAVs are mainly operated through human controller removing the human controller requires automation of UAVs. When comes to

2. Related Works

Chih-Min Lin and Enkh-Amaglan Boldbaatar [1] developed a control system with the recurrent wavelet Elman neural network which achieves better performance than any other control schemes through various simulations. By using fuzzy logic control for automatic landing Akio Kato and Yoshiki Inagaki [2] proves that it was effective and flexible method to land safely. Rini Akmeliawati and Iven M Y Mareels [3] presented a new aircraft automatic landing system with the help of nonlinear energy-based control method (NEM), even

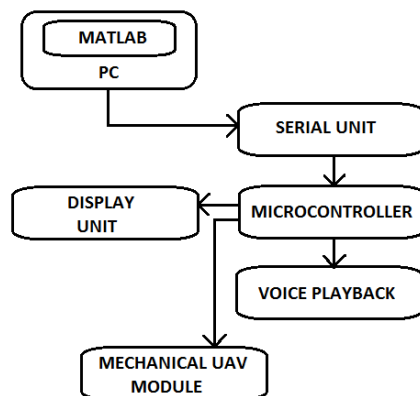


Figure.1 Block diagram of UAV

under extreme conditions the proposed law proves to be effective and behaves well. With the help of electrically driven nonholonomic mobile robots Bong Seok Park, Jin Bae Park, Yoon Ho Choi [4] proposed a new control method which guarantees collision avoidance and presents the simulation results.

Phyo Phyo San, Sai Ho Ling, Nuryani, Hung Nguyen [5] developed a new system to detect hypoglycemia using a evolvable neural network. A new controller using robust recurrent wavelet neural network (RWNN) to track reference trajectories by controlling the permanent magnet linear synchronous motor (PMLSM) was proposed by Faa-Jeng Lin, Li-Tao Teng and Hen Chu [6]. Similarly by using RWNN controller the induction servo motor drive's rotor position was controlled which was proposed by Rong-Jong Wai [7].



Figure.3 Image Adjustment

3. System Overview

3.1. Need for Unmanned Aerial Vehicle

Today's unmanned aerial vehicle has increasingly become a determinant element of the modern warfare. The capabilities of some types of systems are nearly the same or sometimes better than the capabilities of the aircraft handled by a human pilot. These are the reasons that military leaders are looking for this military technology which can be applied efficiently in missions which results in human life.

3.2. Present Scenario and Drawback of Existing System



Figure.4 Hough Transform of Gantrycrane Image

It does not support proper landing and the system is unstable because of time delay son UAV. There is large time delay in 'man-in-the loop' unmanned aircraft vehicle (UAV) system, especially for remote control flight by satellite communication. Time delay has great impact on UAV control, which leads to the system unstable. Current autopilots have limitation, as they encounter situations where 3-D positioning information is lost. The other limitation is the need for way points to determine the next path to follow a desired destination, in which the way points become difficult to locate.

3.3. Solutions to Overcome the Problem

The controller is designed to enable the vehicle to follow reference signals with respect to trajectory path. It has to be designed to enable the vehicle to follow reference signals with



Figure.2 Image of the Input

respect to trajectory and velocity, which are

expressed as functions of the downrange. It is assumed that the closed loop system may use any pilot, human or computer controlled.

The proposed pilot will operate in a pseudo open-loop format by generating flight control signals based on flight time alone. It allows running independent of path data and positioning information. To track the reference signals a control input is generally designed so that one or more ideal transient responses are realized.

3.4. Objective

The controller is designed to enable the vehicle to follow reference signals with respect to trajectory path. The unmanned aerial vehicle, commonly known as a drone, as an unmanned aircraft System or by several other names is an aircraft without a human pilot abroad. The flight of UAVs may operate with various degrees of autonomy either under remote control by human operator or fully or intermittently autonomously by onboard computers.

4. System Architecture

4.1. Proposed Work

The feedback linearization is proposed to improve the control performance of tracking the reference signals and the hyper spectral image processing. A control input is designed so that one or more ideal transient responses are realized. The model is enabled for the vehicle to follow the reference signals and the functions are expressed in downrange.



Figure.6 Mapped Image

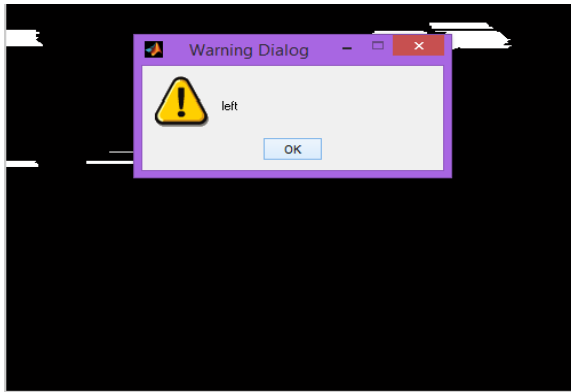


Figure.7 Output Image

4.1. Work Flow

Basically the mechanical UAV module interfaces with microcontroller. The matlab simulation is done and the simulated output is fed as input to the mechanical unit. The image is fed to the MATLAB as input the input image can then be inclined towards left, right, forest or ocean. As shown in the Fig.1, the input image given to the matlab and it is inclined towards the left. The matlab is connected to the serial unit. The function of the serial unit is to transfer the input images to the microcontroller Atmel AT89S52. The AT89S52 is a low-power, high-performance 8-bit microcontroller with programmable Flash memory. This device is manufactured by high-density non-volatile memory technology and it is compatible with the Industry standards. The function of the Atmel AT89S52 is to analyze the landing surface images whether it is inclined towards the left, right or ocean and forest The Atmel

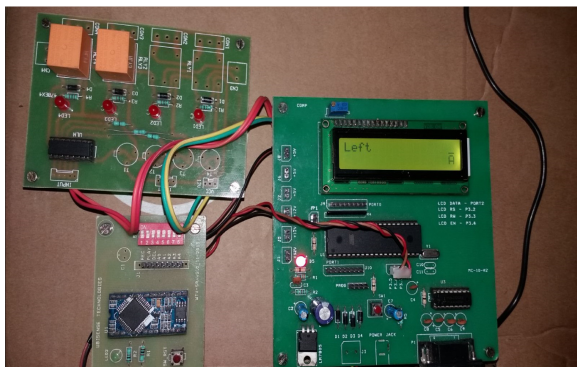


Figure.8 Output Image from Hardware

AT89S52 microcontroller is connected to the voice board APR9600, display unit and a mechanical UAV module. Then the input images are analyzed and transferred to the voice board and display unit. The voice board APR9600 will give voiceover information of the landing surface and the display unit shows the message information of the landing surface.

5. Implementation

The sample image for the left inclination in the MATLAB which results in output image indicated in a warning dialogue box. When interfacing the output image with the Atmel AT89s52 microcontroller using a serial unit connection the processed output is displayed in the LCD display indicating left or right inclination. The indicated output then received by a voice playback unit and played with the help of a speaker. A mechanical UAV module is connected to the microcontroller which consists of a relay switch. The main purpose of relay switch is to manage the power supply given to the circuit.

6. Results and Analysis

At first input image is obtained which is shown in Fig.2 and then the image is converted to grey scale which is shown in Fig.3. After the input image was converted to grey scale they are then adjusted for certain parameters which is displayed in Fig.4, the adjusted image is used for the purpose of Hough transform of gantrycrane image which is shown in Fig. 5. As shown in Fig.6 the Hough transformed image is used to map the surface area of the image. With the mapped image using MATLAB the output image finally shows the surface area in a pop-up which is displayed in Fig. 7. The output image for Hardware after interfacing the MATLAB output is shown in Fig.8.

7. Conclusion and Future Work

In this work at first the importance of UAV was discussed and then various work related to the challenge in landing of the plane was also discussed. Then the brief overview of the system and its architecture was described. Then the implementation was carried out using an input image which was then processed using

MATLAB where the image was converted to gray scale and then adjusted to certain parameters so that the Hough transform of the image needs to be performed. After performing the Hough transform, the image was mapped successfully which then gives the output using a dialog box which shows the inclination of the surface. The main aim of the paper was to monitor the surface and accomplished using input images which was implemented successfully. In this work the input images was compared with the surface and atmospheric conditions. Many considerations were taken to land the unmanned vehicle by checking the surface and inclination angle. Future development of this project is going to be implemented in UAV at real-time. The UAVs have a definite part to play from military perspectives.

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