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Implementation of Field Oriented Control of Three Phase PMSM using Matlab Simulink

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Abstract - *The Permanent Magnet Synchronous Motor (PMSM) has been widely used in the low to medium power system due to its characteristics of high efficiency, high torque to inertia ratio, high reliability and fast dynamic performance. With the advent of the vector control methods, Permanent magnet synchronous motor can be operated like separately excited dc motor high performance application. The complexity of PI controller tuning and high response time is overcome by Fuzzy controller which has less response time and high accuracy without any mathematical calculation .This paper presents a simulation of speed control system on fuzzy logic approach for an indirect vector controlled permanent magnet synchronous drive by applying space vector modulation. The design, analysis and simulation of the proposed system is done using MATLAB.*

Here we have designed a software for automatic control system which has to be linked to a RADAR to detect the position of enemy aircrafts. This process is usually carried out using an asynchronous motor. Here, a permanent magnet synchronous motor(PMSM) is used. Permanent magnet synchronous motors are similar to brushless DC motors. Neodymium magnets are the most commonly used magnets in these motors. Because of the constant magnetic field in the rotor these cannot use induction windings for starting. These motors require a variable-frequency power source to start.

1. INTRODUCTION

*As several areas/zones have become vulnerable to aerial attacks, it has become a necessity for the concealment of turret portion of the combat vehicle. In order that the tanker has to be concealed this proposed system replaces the crew members in the turret region with surveillance camera to monitor the battlefield. The implementation of this project to resolve the problem of replacing humans, because of this we reduce harm of human resource. The SDU 8010 is the armed vehicle's display unit to view the clarified and unclarified inf*ormation on a single display instantaneously and eliminating the need for separate processor units and improving overall access to information when and where its needed. The idea of unmanned turret is achieved by installing multiple camera and all the video information captured by a camera is decoded by raspberry pi and it is sent through a gigabit Ethernet.

2. EXISTING SYSTEM

A model of the BEL Weapon Locating Radar

BEL Weapon Locating Radar: A 3D radar developed from the Rajendra fire control radar for the Akash system, this radar uses a passive electronically scanned array to detect multiple targets for fire correction and weapon location. The system has been developed and demonstrated to the Army and orders have been placed.

Apart from the above, the DRDO has also several other radar systems currently under development or in trials. The systems on which publicly available information is available include:

Active Phased Array radar: Uttam AESA is an indigenously developed active electronically scanned array (AESA) fire control radar. It is being developed for the LCA Mk2 and Mk1 (presumably Mk1s will be upgraded with the system) and also other aircraft upgrades such as the IAF's Jaguars and MiG-29Ks. Hardware has already been realized for this radar which has a range of 100 km against small fighter sized targets and rooftop testing is underway. Though the Uttam AESA currently weighs 120 kg which is some 40 kg more than the current MMR, there will be no problem in integrating it with the LCA Mk-II which can easily carry a radar of this weight. It is a 3D radar for fighters, a MMR follow on, the APAR project aims to field a fully fledged operational AESA fire control radar for the expected Mark-2 version of the Light Combat Aircraft. This will be the second airborne AESA program after the AEW&C project and intends to transfer the success DRDO has achieved in the Ground-based radar segment to airborne systems. The overall airborne APAR

program aims to prevent this technology gap from developing, with a broad based program to bring DRDO up to par with international developers in airborne systems: both fire control and surveillance.

Airborne Warning and Control: Ready for delivery as of 2015. A new radar based on Active Electronically Scanned Array technology. The aim of the project is to develop in house capability for high power AEW&C systems, with the system covering the development of a S Band AESA array. The aircraft will also have datalinks to link fighters plus communicate with the IAF's C3I infrastructure, as well as a local SATCOM (satellite communication system), along with other onboard ESM and COMINT systems.

Products:

- Rajendra Radar
- Central acquisition radar(3D-CAR)-3D radar for akash missile
- Indra series
- BEL battle field surveillance radar(short range)
- BEL weapon locating radar

3. PROPOSED SYSTEM

Swathi WLR was indigenously developed by the Defence Research and Development Organisation (DRDO) and manufactured by BEL.

It is an electronically scanned phased array radar and automatically locates hostile artillery, mortars and rocket launchers and tracks friendly fire to locate the impact point of friendly artillery fire to issue necessary corrections.

It is interesting to note that during the Kargil conflict in 1999, Indian Army faced limitations as it did not have any WLRs and they were the first weapon systems procured from the U.S. once the defence sales commenced a few years later.

According to the DRDO, the radar is designed to detect projectiles with small cross section across the battle space horizon, and has the capability to handle simultaneous fire from weapons deployed at multiple locations.

"The radar uses advanced signal processing techniques for detection and tracking projectiles in the presence of ground, weather clutter and other forms of interference in Electronic Warfare scenario," the DRDO website says.

4. COMPONENT DETAILS

MATLAB:

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

The MATLAB mathematical function library.

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

The MATLAB Application Program Interface (API).

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

Interfacing with other languages

MATLAB can call functions and subroutines written in the programming languages C or Fortran. A wrapper function is created allowing MATLAB data types to be passed and returned. MEX files (MATLAB executables) are the dynamically loadable object files created by compiling such functions. Since 2014 increasing two-way interfacing

with Python was being added.Libraries written in Perl, Java, ActiveX or .NET can be directly called **from** MATLAB, and many MATLAB libraries

(for example XML or SQL support) are implemented as wrappers around Java or ActiveX libraries. Calling MATLAB from Java is more complicated, but can be done with a MATLAB toolbox which is sold separately by MathWorks, or using an undocumented mechanism called JMI (Java-to-MATLAB Interface), (which should not be confused with the unrelated Java Metadata Interface that is also called JMI).

5. EXPERIMENTALSETUP

Defence applications are completely controlled by electronic circuits. RADAR ie. RAdar Detection And Ranging is the most important development in the electronics field. By sending out pulses of radio waves which are reflected off the object back to the source. RADAR is something in use all around us like in air traffic control used to track planes, police used to detect the speed of passing motorists. Meteorologists use it to track storms, hurricanes and tornadoes.

- Detect the presence of an object at a distance (moving or stationary)
- Detect speed of an object
- Map something – orbiting satellites use RADAR to create topographic maps.

All these are achieved by Echo or Doppler shift.

Echo- sound waves reflect off a surface and come back a moment later.

Doppler shift – consider a car travelling towards the right and horn sound from the car heard by the driver is of higher tone compared to the person behind the car and of lower tone compared to the person ahead of the car.

The actual change in frequency due to relative motion of source and observer is called a Doppler shift.

As discussed earlier, with the help of radar it is possible to detect and find the exact location of enemy aircraft. Radar and Anti-craft guns can be linked by an automatic control system to make a complete unit.

The main concerns of a motor control industry are to reduce cost, power consumption and electromagnetic radiations. We have used TMS320C240, specifically used for the digital motor control segment.

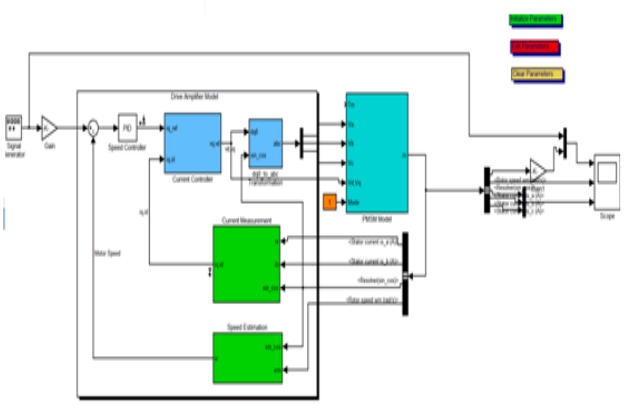
The setup consists of a Signal generator, gain amplifier, PID controllers for controlling various parameters such as speed, position (angle) and current.

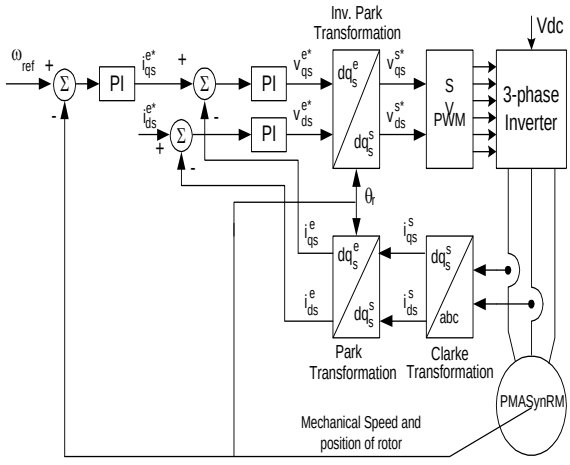
The radar linked with PMSM motor detects the exact position (latitude and longitude) and speed of the obstacle. The above obtained values are Stator currents of the motor in Ampere units, Resolver in sine-cosine angles and Rotor speed (Wm) in radians per second.

The two stator currents and resolver values are fed to the current measurement block. The output of this block is the resultant current value in the dq axis. The rotor speed and resolver values are fed to the speed estimation block to determine the resultant speed value.

With the help of a continuous power guide, a constant sinusoidal signal is generated by the signal generator which can be amplified by a gain amplifier as per requirements. This input signal is modulated with respect to the motor speed feedback from speed estimation block using the PID Speed controller. This modulated signal is further modulated with respect to the resultant stator current using a Current controller. Since the PMSM motor is a three phase synchronous motor and the output of the current controller is two phase (dq axis) voltage, a transformation from dq to abc (Park Transformation) coordinates is implemented. The output of this transformation is three- phase voltages Va, Vb, Vc. This is fed to the motor and the mode value of the motor is switched to 1. Thus enabling the Anti-Craft gun linked to the PMSM motor unit to target the exact location of the moving obstacle. Since PMSM motors have Low rotor inertia, it is easy to control the position and angle.

BLOCK DIAGRAM





6. CONCLUSIONS

From the proposed system we could make surveillance unmanned by integrating Raspberry Pi and Smart Display Unit and by establishing a secured connection we can transmit the video signal seamlessly to the end user in the hull. In addition to this we could synchronize various controllers intended for specific function like inertial navigation unit and GPS module and replace multiple display unit for various controllers with SD8010 thereby providing a better solution to the space constraint in the army tankers. For this special issue, our aim is to bring together researchers designing or developing advanced image processing techniques/systems, with a particular emphasis on defence and security applications. In near future this approach of battlefield surveillance can be implemented in Unmanned Ground Vehicles (UGV). These UGVs would be used for weapon platforms, logistic carriers and reconnaissance, surveillance and target acquisitions.

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