

```

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">

<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" lang="en">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8"/>
<script type="text/javascript" src="../sitescripts.js"></script>
<link rel="stylesheet" href="../style.css" type="text/css" media="screen" ti-
tle="Minimalistic" />
<title>Research — Quaternion Valued Signal Processing there4; Dr. Danilo P.
Mandic</title>

</head>
<body>

<div id="header">
<a class="left" href="index.htm"><!-- Dr. Danilo Mandic</a>
<ul>
<li><a href="http://www.imperial.ac.uk"><!-- Imperial College</a></li>
<li><a href="http://www.ee.ic.ac.uk"><!-- EEE</a></li>
<li class="last"><a href="http://www.commisp.ee.ic.ac.uk/"><!-- CSP Research Group</a></li>

</ul>
</div> <!-- header -->

<div id="container">
<div id="sidebar">
<ul>
<li><a href="../index.htm"><!-- Home</a></li>
<li><a class="current" href="../research.htm"><!-- Research</a></li>
<li><a href="../publications.htm"><!-- Publications</a></li>

<li><a href="../keynotes.htm"><!-- Keynotes</a></li>
<li><a href="../awards.htm"><!-- Awards</a></li>
<li><a href="../personal.htm"><!-- Personal</a></li>
<li><a href="../grants.htm"><!-- Research Grants</a></li>
<li><a href="../duties.htm"><!-- Professional Duties</a></li>
<li><a href="../courses.htm"><!-- Courses</a></li>

<li><a href="../dvv.htm"><!-- DVV Toolbox</a></li>
<li><a href="../collaborators.htm"><!-- Collaborators</a></li>
</ul>
</div> <!-- sidebar -->
<div id="content">
<h1>Quaternion Valued Signal Processing</h1>

```

ip; Widely Linear Modeling, Quaternion LMS (QLMS), Quaternion widely linear LMS (WLQLMS), Adaptive Prediction, Wind Forecasting. You can also download the Matlab codes for most of quaternion-valued adaptive filters described in the articles below

[ja class="matlab" href="Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title = "downloadMATLABcode" > \[MATLABcode\] < /a >< /p >](#)

< p >

< strong > Legend < /strong >:

< imgsrc = "../images/matlab - icon.gif" / > MATLABcode,

< imgsrc = "../images/pdf - icon.gif" / > PDF files,

< imgsrc = "../images/zip - icon.png" / > Supplementsanddata.

< p >

< olid = "research - work" >

<!--C.UjangBukhari,C.Jahanchahi,C.Cheong-Took,andD.P.Mandic,\Anadaptiveconvexcombinationofwide-linearLMSandQuaternionLMSforpredictionofwide-sensestationaryquaternionrandomsignals",SignalProcessing,inprint,2013.

-- >

< li > C.JahanchahiandD.P.Mandic,< strong > "AclassofquaternionKalmanfilters",< /strong > IEEETransactionsonNeuralNetworksandLearningSystems,vol.52,no.3,pp.533-544,2014.

< span >

< aclass = "pdf"href = "CJC_PMQQuaternionWL_Kalman_IEEE_TNNLS2014.pdf" title = "downloadinPDFform" > [pdf] < /a >< /span >

< /li >

< li > C.UjangBukhari,C.Jahanchahi,C.Cheong-Took,andD.P.Mandic,< strong > "Anadaptiveconvexcombinationapproachfortheidentificationofimproperquaternionprocesses",< /strong > IEEETransactionsonNeuralNetworksandLearningSystems,vol.25,no.1,pp.172-182,2014.

< span >

< aclass = "pdf"href = "Quaternionstuff/CUB_CTD_PMQQuaternionadaptiveIdentification_IEEE_TNNLS2014.pdf" title = "downloadinPDFform" > [pdf] < /a >

< aclass = "matlab"href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title = "downloadMATLABcode" > [MATLABcode] < /a >

< /span >

< /li >

< li > J.Navarro-Moreno,J.FernandezAlcala,C.CheongTook,andD.P.Mandic,< strong > "Predictionofwide - sensestationaryquaternionrandomsignals",<

/strong> SignalProcessing, vol.93, no.9, pp.2573 – 2580, 2013.

< span >

*< aclass = "pdf" href = "Quaternionstuff/MorenowSSQuaternionSigProc2013.pdf" >
10.pdf" title = "downloadinPDFform" > [pdf] < /a >*

*< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"downloadMATLABcode" > [MATLABcode] < /a >*

< /span >

< /li >

*< li > C.JahanchahiandD.P.Mandic, < strong > "AnadaptivediffusionquaternionLMSalgorithmford
/strong >, inProceedingsofEUSIPCO'13, pp.2013.*

< span >

*< aclass = "pdf" href = "Quaternionstuff/CJDPMDiffusionQLMS_EUSIPCO2013.pdf" >
10.pdf" title = "downloadinPDFform" > [pdf] < /a >*

*< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"downloadMATLABcode" > [MATLABcode] < /a >*

< /span >

< /li >

*< li > F.TobarandD.P.Mandic, < strong > "Quaternionkernelleast-squares" <
/strong > inProceedingsofICASSP'13, pp.6128–6132, 2013.*

< span >

*< aclass = "pdf" href = "Quaternionstuff/FATDPMQuaternionKernelLMS_ICASSP2013.pdf" >
10.pdf" title = "downloadinPDFform" > [pdf] < /a >< /span >*

< /li >

*< li > C.Jahanchahi, C.CheongTook, andD.P.Mandic, < strong > "Aclassofquaternionvaluedaffinepr
/strong > SignalProcessing, vol.93, no.9, pp.1712–1723, 2013.*

< span >

*< aclass = "pdf" href = "Quaternionstuff/CJCTDPMAffineQuaternionFilteringsignalprocessing2
10.pdf" title = "downloadinPDFform" > [pdf] < /a >*

*< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"downloadMATLABcode" > [MATLABcode] < /a >*

< /span >

< /li >

*< li > D.Dini, C.Jahanchahi, andD.P.Mandic, < strong > "Widelylinearcomplexandquaternionvalued
/strong > IETSignalProcessing(invited), vol.6, no.5, pp.435–445, 2012.*

< span >
 < aclass = "pdf" href = "Quaternionstuff/DDCJ_DPM_Kalman_Bearings_Only_Tracking_IET_SP₂012.pdf" > [pdf] < /a >< /span >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >< /span >
 < /li >

< li > C.Jahanchahi, C.CheongTook, and D.P.Mandic, < strong > "On gradient calculation in quaternion
 /strong > in Proceedings of ICASSP'12, 3773–3776, 2012.
 < span >
 < aclass = "pdf" href = "Quaternionstuff/CJ_CCT_DPM_Quaternion_Gradient_ICASSP₂012.pdf" title =
 "downloadinPDFform" > [pdf] < /a >< /span >
 < /li >

< li > C.U.Bukhari, C.CheongTook, and D.P.Mandic, < strong > "On quaternion analyticity :
 Enabling quaternion valued nonlinear adaptive filtering", < /strong > in Proceedings of ICASSP'12, pp.2
 < span >
 < aclass = "pdf" href = "Quaternionstuff/CUB_CCT_DPM_Quaternion_RNN_SI_CASSP₂012.pdf" title =
 "downloadinPDFform" > [pdf] < /a >
 < aclass = "matlab" href = "Quaternionstuff/Matlab_Code_Quaternion_Adaptive_Filters.zip" title =
 "downloadMATLABcode" > [MATLABcode] < /a >
 < /span >
 < /li >

< li > M.Wang, C.CheongTook and D.P.Mandic, < strong > "A class of fast quaternion valued variable step
 /strong > in Proceedings of IJCNN'11, pp.1700 – 1705, 2011.
 < span >
 < aclass = "pdf" href = "Quaternionstuff/Quaternion_Adaptive_GASS_IJCNN₂011.pdf" >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >< /span >
 < /li >

< li > S.Javidi, C.Cheong–Took, and D.P.Mandic, < strong > "A Fast Independent Component Analysis
 /strong > IEEE Transactions on Neural Networks, vol.22.no.12, pp.1967–1978, 2011.
 < span >
 < aclass = "pdf" href = "SJ_CCT_DPM_QFast_ICA_IEEE_TNN₂011.pdf" >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >< /span >
 < /li >

< li > C.Cheong – Took and D.P.Mandic, < strong > "Augmented Second –
 order Statistics of Quaternion Random Signals," < /strong > Signal Processing, vol.91, pp.214–
 224, 2011.

< span >
 < aclass = "pdf" href = "Quaternionstuff/CCT_DPM_AugmentedQuatstatistics₂₀₁₁.pdf" >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >
 < aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternion_AdaptiveFilters.zip" title =
 "downloadMATLABcode" > [MATLABcode] < /a >
 < /span >
 < br >

< ahref = "Quaternionstuff/QuatstatAddendum_SP₂₀₁₁.pdf" > < em >
 Addendumtothepaperandsomeclarifications < /em > < /a > < span > <
 /span >
 < /li >

< li > C.CheongTook, C.Jahanchahi, and D.P.Mandic, < strong > "Aunifyingframeworkfortheanalysis
 valuedadaptivefilters," < /strong > in *ProceedingsoftheAsilomarConferenceonSignals, Systems, and*

< span >
 < aclass = "pdf" href = "Quaternionstuff/CJ_CCCT_DPM_QLMS_Aalysis_{Asilomar}₂₀₁₁.pdf" >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >
 < aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternion_AdaptiveFilters.zip" title =
 "downloadMATLABcode" > [MATLABcode] < /a >
 < /span >
 < /li >

< li > C.U.Bukhari, C.Cheong–Took, and D.P.Mandic, < strong > "QuaternionValuedNonlinearAdapt
 /strong > *IEEETransactionsonNeuralNetworks*, vol.22, no.8, pp.1193–1206, 2011.

< span >
 < aclass = "pdf" href = "Che_Clive_Danilo_{Quat}_Nonlin_{Filt}_{IEEE_TNN}₂₀₁₁.pdf" >
 10.pdf" title = "downloadinPDFform" > [pdf] < /a >

< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternion_AdaptiveFilters.zip" title =
 "downloadMATLABcode" > [MATLABcode] < /a > < /span >
 < /li >

< li > D.P.Mandic, C.Jahanchahi, and C.Cheong–Took, < strong > "Aquaterniongradientoperatorand
 /strong > *IEEESignalProcessingLetters*, vol.18, no.1, pp.1–5, 2011.

< span >
 < aclass = "pdf" href = "Quaternionstuff/DMP_CJ_CCTQuaternion_Gradient_{IEEE_SPL}₂₀₁₁.pdf" title =
 "downloadinPDFform" > [pdf] < /a >

< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternion_AdaptiveFilters.zip" title =
 "downloadMATLABcode" > [MATLABcode] < /a >
 < /span >

< /li >

< li > C.Cheong–Took, D.P.Mandic, and F.Zhang, < strong > ”On Unitary Diagonalisation of a Special Case of the Quaternion–Valued Short-Term Forecasting of Three-Dimensional Wind and Atmospheric Parameters,” < /strong > *Applied Mathematics Letters*, vol.24, pp.1806 – 1809, 2011.

< span >

< aclass = ”pdf” href = ”Quaternionstuff/CCT_DPM_FZQuaternionDiagonalisationAppliedMathsLetters2011.pdf” title = ”downloadinPDFform” > [pdf] < /a >

< /span >

< /li >

< li > S.Javidi, C.CheongTook, C.Jahanchahi, N.LeBihan, and D.P.Mandic, < strong > ”Blind Extraction of Improper Quaternion Sources,” < /strong > *in Proceedings of ICASSP’11*, pp.3708 – 3711, 2011.

< span >

< aclass = ”pdf” href = ”Quaternionstuff/Soroush_qBSE_IICASSP2011.pdf” title = ”downloadinPDFform” > [pdf] < /a >

< /span >

< /li >

< li > C.Cheong – Took, G.Strbac, K.Aihara, and D.P.Mandic, < strong >

”Quaternion–valued short-term forecasting of three–dimensional wind and atmospheric parameters,” < /strong > *Renewable Energy*, vol.36, pp.1754 – 1760, 2011.

< span >

< aclass = ”pdf” href = ”Quaternionstuff/CCT_DPM₃DWindRenewableEnergy2011.pdf” title = ”downloadinPDFform” > [pdf] < /a >

< aclass = ”matlab” href = ”Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip” title = ”downloadMATLABcode” > [MATLABcode] < /a >

< /span >

< /li >

< li > C.Jahanchahi, C.Cheong–Took and D.P.Mandic, < strong > ”A Widely Linear Quaternion Recursive Least Squares Algorithm,” < /strong > *in Proceedings of the Cognitive Information Processing Conference*, pp.87–92, 2010.

< span >

< aclass = ”pdf” href = ”Quaternionstuff/CyrusWLQRLS_CIP2010.pdf” title = ”downloadinPDFform” > [pdf] < /a >

< aclass = ”matlab” href = ”Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip” title = ”downloadMATLABcode” > [MATLABcode] < /a >

< /span >
< /li >

< li > C.Cheong–Took, D.P.Mandic, and J.Benesty, < strong > "Study of the quaternion LMS and four-channel LMS algorithms," < /strong > in *Proceedings of ICASSP'09*, pp. 3109–3112, 2009.
< span >
< aclass = "pdf" href = "Quaternionstuff/CCTDPMJBQLMSvsMultichannelLMSICASSP2010.pdf" >
"download in PDF form" > [pdf] < /a >
< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"download MATLAB code" > [MATLAB code] < /a >
< /span >
< /li >

< li > C.Cheong–Took and D.P.Mandic, < strong > "A Quaternion Widely Linear Adaptive Filter," < /strong > *IEEE Transactions on Signal Processing*, vol. 58, no. 8, pp. 4427–4431, 2010.
< span >
< aclass = "pdf" href = "Quaternionstuff/TookMandicWLQLMSIEEE_TSP2010.pdf" title =
"download in PDF form" > [pdf] < /a >
< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"download MATLAB code" > [MATLAB code] < /a >
< /span >
< /li >

< li > C.Cheong–Took, D.P.Mandic, and K.Aihara, < strong > "Quaternion-valued short-term forecasting of wind profile," < /strong > in *Proceedings of IJCNN*, pp. 3412–3417, 2010.
< span >
< aclass = "pdf" href = "Quaternionstuff/TookMandicQuaternionWindIJCNN2010.pdf" title =
"download in PDF form" > [pdf] < /a >
< aclass = "matlab" href = "Quaternionstuff/MatlabCodeQuaternionAdaptiveFilters.zip" title =
"download MATLAB code" > [MATLAB code] < /a >
< /span >
< /li >

< li > C.Cheong–Took and D.P.Mandic, < strong > "The Quaternion LMS Algorithm for Adaptive Filtering of Hypercomplex Processes," < /strong > *IEEE Transactions on Signal Processing*, vol. 57, no. 13, pp. 1327–1337, 2009.
< span >
< ! < aclass = "pdf" href = "http://dx.doi.org/10.1098/rspa.2009.0502" title =
"download in PDF form" >
< ! [pdf] < /a >

< aclass = "pdf" href = "Quaternionstuff/Quaternion_LMS_IEEE_TSP_2009.pdf" title =
"downloadinPDFform" > [pdf] < /a >

< aclass = "matlab" href = "Quaternionstuff/Matlab_CodeQuaternion_Adaptive_Filters.zip" title =
"downloadMATLABcode" > [MATLABcode] < /a >
< /span >
< /li >

< li > C.Cheong–Took and D.P.Mandic, < strong > "Quaternion–Valued Stochastic Gradient–
Based Adaptive IIR Filtering," < /strong > IEEE Transactions on Signal Processing, vol.58, no.7, pp.389
3901, 2010.
< span >
< aclass = "pdf" href = "Quaternionstuff/Quaternion_IIR_IEEE_TSP_2010.pdf" title =
"downloadinPDFform" > [pdf] < /a >
< /span >
< /li >

< li > B.C.Ujang, C.Cheong–Took and D.P.Mandic, < strong > "Split quaternion nonlinear adaptive filter
/strong > Neural Networks, vol.23, no.3, pp.426 – 434, 2010.
< span >
< aclass = "pdf" href = "Quaternionstuff/Che_SplitQuaternion_NN_2010.pdf" title =
"downloadinPDFform" > [pdf] < /a >
< /span >
< /li >

< li > C.Cheong–Took and D.P.Mandic, < strong > "Fusion of Heterogeneous Data Sources :
A Quaternionic Approach," < /strong > Proceeding of MSLP'09,
pp.456 – 461, 2008.
< span >
< aclass = "pdf" href = "Data_Fusionstuff/CliveQuaternion_Fusion_MLSP_2008.pdf" title =
"downloadinPDFform" > [pdf] < /a >

< aclass = "matlab" href = "Quaternionstuff/Matlab_CodeQuaternion_Adaptive_Filters.zip" title =
"downloadMATLABcode" > [MATLABcode] < /a >
< /span >
< /li >

< /ol >

< /div > < ! – – content – – >

< divid = "footer" >
< ul >

```

< li >< spanid = "update" >< scripttype = "text/javascript" > document.write(lastMod());<
/script >< /span >< /li >

< li > Valid < ahref = "http : //validator.w3.org/check/referer" > XHTML <
/a >< /li >
< liclass = "last" > Valid < ahref = "http : //jigsaw.w3.org/css-validator/check/referer?warning =
noamp;profile = css2" > CSS < /a >< /li >
< /ul >
< /div ><! -- footer -- >

< /div ><! -- container -- >

< /body >
< /html >

```