Information Required

Section A: Overview of the Research Project Proposal

1. Academic level of research project: **Doctoral**

2. Broad field of research: **Engineering**

3. Title of the research project: **Investigate Technique to Enhance Gain and Bandwidth of K-band Antenna Array for Radio Astronomy**

4. Research project abstract/summary (max 250 words):

In this project, we explore a potential technique/approach which will significantly enhance both the gain/directivity and bandwidth of the proposed antenna in K-band frequency regime of the spectrum. For this purpose, a thorough study of various reported techniques for gain enhancement and bandwidth enhancement, individually as well as collectively will be performed with their comparative analysis. However, we would like to emphasize over metamaterials, photonic crystal and frequency selective surface. Further, we will analyse and simulated the unit-cell of the proposed antenna at K-band frequency with employing the selected material/technique and perform experimental validation. In addition to this, we will simulate the array configuration of the proposed unit-cell antenna and explore an intelligent algorithm for beam steering. Finally, a prototype antenna array would like to develop for SKA.

Section B: Supervisor(s) Details

1. Primary supervisor's details

a. Title and full name: **Prof. Ghanshyam Singh**

b. Name of South African or SKA Partner Country university at which the primary supervisor is a permanent academic staff member: **University of Johannesburg, APK Campus, Johannesburg, S Africa**

c. Email address and/or contact telephone number (please note that in the event this project is approved, these contact details will be made available to students awarded SARAO postgraduate bursaries): **Department of Electrical and Electronics Engineering Sciences,**
Faculty of Engineering and the Built Environment
University of Johannesburg
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ghanshyams@uj.ac.za
Skype ID: ghanshyam-singh
Tel.: +27 11 559 3879

d. Supervision of postgraduate students – please provide the details of all the previous and current postgraduate students supervised. Please provide the information in table format, as shown below.

i. Doctoral Students

Name of student	Nationality	Date started Doctoral Degree (Month and Year)	Date completed / will complete Doctoral Degree	Title of Research Project / Thesis	Co-Supervisor (if relevant)

			(Month and Year)		
P Kumar	Indian	Jan. 2007	Oct. 2009	Design and analysis of multi-frequency broadband microstrip patch antenna	Prof. S V Bhooshan
Ajay K Singh	Indian	Jan. 2007	Nov. 2010	Analytical study of pulse-shaping and frequency allocation of software defined radio	N/A
Viranjay M Srivastava	Indian	July 2008	Nov. 2011	Analysis and design of double-pole four through RF switch by using novel MOSFET technologies	Dr K S Yadav
Kumud R Jha	Indian	July 2008	Dec. 2011	Analysis and design of highly directive microstrip terahertz antennas for wireless communication systems	N/A
Vivek K Dwivedi	Indian	July 2008	Feb. 2012	Analysis of bit-error-rate and channel capacity of the OFDM communication system	N/A
Pradeep K Gupta	Indian	Jan. 2009	Dec. 2012	Energy sustainable framework and algorithms to minimize power consumption by personal computers	N/A
S Kumar	Indian	Jan. 2009	April 2013	Analysis of multipath fading channel models for next generation	Prof. D S Chauhan

				wireless communication system	
S V R K Rao	Indian	July 2008	Dec. 2013	Analysis of sensing time and signal-to-interference noise ratio for cognitive radio system	N/A
Shweta Pandit	Indian	July 2012	June 2015	Medium access control protocol for spectrum sharing in cognitive radio communication system	N/A
Garima Bharti	Indian	July 2012	June 2015	Analysis and design of frequency selective surface at Ka/Ku band for reflection and S band for transmission for satellite communication system	N/A
Indu Bala	Indian	July 2013	Sept 2017	Study and development of power control schemes for cognitive radio networks	Prof M S Bhamrah
Isha Malhotra	Indian	July 2012	Dec. 2017	Analysis, design and characterization of photoconductive dipole antenna for terahertz imaging applications	N/A
Prabhat Thakur	Indian	Nov. 2016	March 2018	Mathematical modelling of spectrum sharing for cognitive radio communication systems	N/A

Alok Kumar	Indian	Nov. 2016	Progress	Energy efficient spectrum sensing for cognitive radio communication system	N/A
Uri N	Israel	June 2018	Progress	Terahertz antenna for future generation communication systems	N/ A
K Katoch	Indian	June 2018	Progress	Millimeter wave dielectric resonator antenna for future generation communication systems	N/A

ii. Masters Students

Name of student	Nationality	Date started Masters Degree (Month and Year)	Date completed / will complete Masters Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor (if relevant)
S Galoda	Indian	July 2006	June 2007	Terahertz technology – recent advances in imaging and communication	N/A
S Thakur	Indian	July 2006	June 2007	Metamaterial- a new artificial material for advanced communication systems	N/A
D Kumar	Indian	July 2006	June 2007	Terahertz wave propagation in indoor wireless communication	N/A
A Sharma	Indian	July 2007	June 2008	Design consideration of rectangular microstrip patch antenna at THz frequencies for advanced communication systems	N/A
R N Tiwari	Indian	July 2007	June 2008	Conceptualization of nano-circuit elements by meta-materials at optical frequency	N/A

R Kumar	Indian	July 2007	June 2008	Metamaterial ─ applications in microwave and optical frequency domain	N/A
H Parashar	Indian	July 2010	June 2011	Effects of coupling and switching on crosstalk in RFIC interconnects	N/A
S Kapoor	Indian	July 2010	June 2011	An integrated model for non-cooperative spectrum sensing in cognitive radio	N/ A
G Garg	Indian	July 2010	June 2011	Realization and study of analog filter using DVCCs	N/A
Ankush Kapoor	Indian	July 2011	June 2012	Frequency selective surface for antenna miniaturizations	N/A
R Guleria	Indian	July 2011	June 2012	Optical OFDM	N/A
Ila Sharma	Indian	July 2011	June 2012	Spectrum management for cognitive radio network by using fuzzy logic	N/A
T Gupta	Indian	July 2011	June 2012	Side-lobe suppression in OFDM based cognitive radio	N/A
G Bharti	Indian	July 2011	June 2012	Analysis and simulation of optical dipole antenna	N/A
S Pandit	Indian	July 2011	June 2012	Spectrum sharing by using multiple antennas	N/A
Harsh M	Indian	July 2011	June 2012	Spectrum management for cognitive radio by using multi-antenna	N/A
K K Chaure	Indian	July 2012	June 2013	Design and synthesis of frequency selective surfaces for satellite communication system	N/A
V Devrani	Indian	July 2012	June 2013	Analysis and design of microstrip patch antenna using double negative metamaterials at	N/A

				terahertz frequency for communications	
Setu P Singh	Indian	July 2012	June 2013	Design analysis of a dual band microstrip antenna in L and S band	N/A
Bindu Bharti	Indian	July 2014	June 2015	Optimal power allocation to cognitive user under joint power constraints with imperfect channel state information	N/A
A Sharma	Indian	July 2014	June 2015	Marginal moment generating function based suboptimal adaptive analysis for generalized-k fading — a composite model for fading channels	N/A
H Sood	Indian	July 2014	June 2015	Performance assessment of device beyond the scaling limits — double-gate and surrounding-gate MOSFET	N/A
D Negi	Indian	July 2015	June 2016	Design of microstrip-line feed rectangular microstrip antenna at 60/77 GHz for defense applications	N/A
E Thakur	Indian	July 2015	June 2016	Inset feed microstrip antenna design at60/77 GHz for next generation communication system	N/A
A Thakur	Indian	July 2015	June 2016	Spectrum sharing techniques — A comprehensive study	N/A
K Katoch	Indian	July 2016	June 2017	Analysis and design of dielectric resonator antenna at terahertz frequency for next generation communication system	N/ A

A Garg	Indian	July 2016	June 2017	Design and analysis of curved frequency selective surfaces for intelligent transport system	N/A
N Sharma	Indian	July 2017	June 2018	Terahertz antenna design for intelligent transport system	N/A

2. Co-supervisor / Research Supervisor's details (if relevant): **N/ A**

a. Title and full name

b. Name of the university/institute, at which the co-supervisor/research supervisor is a permanent academic/research staff member

c. Email address and/or contact telephone number (please note that in the event this project is approved, these contact details will be made available to students awarded SARAO postgraduate bursaries)

d. Supervision of postgraduate students – please provide the details of all the postgraduate students supervised. Please provide the information in table format, as shown below.

i. Doctoral Students

Name of student	Nationality	Date started Doctoral Degree (Month and Year)	Date completed / will complete Doctoral Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor (if relevant)

ii. Masters Students

Name of student	Nationality	Date started Masters Degree (Month and Year)	Date completed / will complete Masters Degree (Month and Year)	Title of Research Project / Thesis	Co-Supervisor (if relevant)

Section C: Full Research Project Proposal

Maximum of three A4 pages, written for a professional who is not necessarily an expert in the relevant subfield

1. Scientific merit: describe the objectives of the research project, placing them in the context of the current key questions and understanding of the field.

For the radio astronomy, the frequency resolution is needed for spectral line observations which rely on the cosmic object observed with the purpose of the observations, and the frequency employed for observation. The spectrometers generally have several thousand frequency channels; therefore, a large bandwidth is required in order to cover several spectral lines as well as study the shapes of emission lines. In general, the spectrometers used in radio astronomy have total bandwidths of up to several GHz. Due to this reason, we would like to explore K-band frequency for antenna for radio astronomy. Further, we also would like to significantly enhance the bandwidth. The array configuration of the proposed antenna generally enhances the gain and directivity. However, how further enhancement in the gain/directivity as well as bandwidth is challenging research issue. Further, it is important to note that the signal strength of radio frequency interference (RFI) is often much larger than that of the cosmic source. Therefore, the RFI entering the system through side lobes is a severe problem. Finally, in this project, we would like to explore the research problem such as:

1) Bandwidth enhancement of the proposed antenna.

2) Gain and directivity enhancement.

3) Minimize the challenging research issue of radio frequency interference, and

4) Develop an excellent man power for SKA

2. Feasibility: outline the methods that will be used to achieve the objectives. Provide details on the availability of required data / access to required equipment / availability of research facilities and other resources required. Include any relevant expected intermediate milestones and associated timeframes towards attaining the overall objectives of the project.

The University of Johannesburg is rich in literatures (Journals, Conference Book). We have Ansoft HFSS which will be used for simulation purposes and for experimentation, we have very good collaboration with Shri Mata Vaishno Devi Universty, India which have up to 40 GHz antenna testing facility.

3. Link the proposed project to at least one SARAO research priority areas (refer to Annexure 1 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).

As discussed in Section C (1). Related to the demand of bandwidth, gain/directivity and radio frequency interference.

4. If relevant, describe any particular qualifications, academic abilities, skills and/or experience that a student should have in order to successfully deliver on the objectives of the research proposed.

The student has master's degree in electrical/Electronic or Computer Engineering.

Section D: Signatures

(Prof. G Singh), August 30, 2018

1. Signature of the primary supervisor, with date