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IMPORTANT DATES

Paper Submission: *October 31, 2021*
Notification of Acceptance: *December 31, 2021*
Camera-ready Papers: *January 31, 2022*
Registration: *February 28, 2022*
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Patents

PSU welcomes and supports new innovations and patents. Currently, 8 patents have been submitted by PSU. Four of these patents have been granted and registered under PSU.

US 20210265919A1

(19) **United States**

(12) **Patent Application Publication**

BHASKAR et al.

(10) **Pub. No.: US 2021/0265919**

(43) **Pub. Date: Aug. 26, 2**

(54) **MICROGRID POWER SUPPLY SYSTEM DC-DC CONVERTER AND CONTROLLING METHOD**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventors: **Mahajan Sagar BHASKAR**, Riyadh (SA); **Dhafer J. ALMAKHLES**, Riyadh (SA); **Umashankar SUBRAMANIAM**, Riyadh (SA); **Sanjeevikumar PADMANABAN**, Riyadh (SA); **Sakthivel RATHINASAMY**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(21) Appl. No.: **16/798,532**

(22) Filed: **Feb. 24, 2020**

Publication Classification

(51) **Int. Cl.**

H02M 7/483 (2006.01)

H02J 1/10 (2006.01)

G06F 1/26 (2006.01)

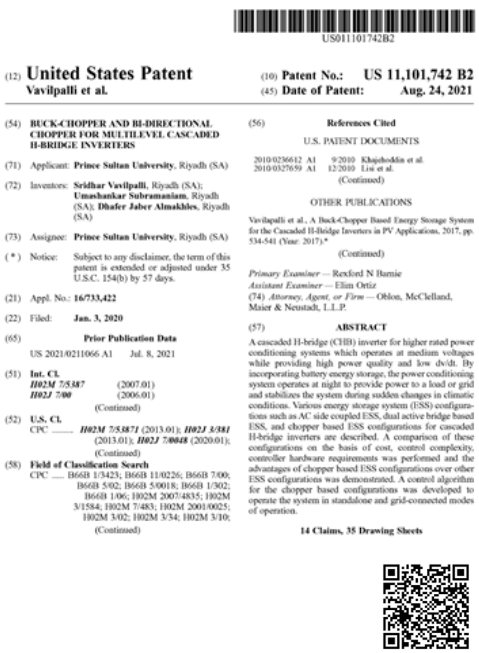
H02M 1/36 (2006.01)

(52) **U.S. Cl.**

CPC ..... ***H02M 7/483*** (2013.01); ***H02J 1*** (2013.01); ***H02M 2007/4835*** (2013.01); ***H 1/36*** (2013.01); ***G06F 1/263*** (201

(57) **ABSTRACT**

A DC-DC voltage converter includes an input circ parallel linked leg (PLL), an output circuit and a contr The PLL includes an active leg switch, a leg inductor, capacitor and a leg diode. The controller is configured turn on the active input switch and the active leg swi while maintaining the active output switch at a turn off for the first duty cycle period ii) turn off the active switch and the active leg switches, and turn on the a output switch for a second duty cycle period followin first duty cycle period, and iii) turn off the active o switch while maintaining also turn off states of the a input switch and the active leg switches for a rema period following the second duty cycle period. A meth controlling the DC-DC converter includes steps of i)



US011101742B2

(12) **United States Patent**

Vavilpalli et al.

(10) **Patent No.: US 11,101,742 B2**

(45) **Date of Patent: Aug. 24, 2021**

(54) **BUCK-CHOPPER AND BI-DIRECTIONAL CHOPPER FOR MULTILEVEL CASCADED H-BRIDGE INVERTERS**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventors: **Sridhar Vavilpalli**, Riyadh (SA); **Umashankar Subramaniam**, Riyadh (SA); **Dhafer Jaber Almakhles**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 57 days.

(21) Appl. No.: **16/733,422**

(22) Filed: **Jan. 3, 2020**

(65) **Prior Publication Data**

US 2021/0211066 A1 Jul. 8, 2021

(51) **Int. Cl.**

H02M 7/5387 (2007.01)

H02J 7/00 (2006.01)

(52) **U.S. Cl.**

CPC ***H02M 7/5387*** (2013.01); ***H02J 7/00*** (2013.01); ***H02J 7/0068*** (2020.01);

(58) **Field of Classification Search**

CPC B66B 1/3423; B66B 11/0226; B66B 7/00; B66B 5/02; B66B 5/0018; B66B 1/302; B66B 1/06; H02M 2007/4835; H02M 3/1584; H02M 7/483; H02M 2001/0025; H02M 3/02; H02M 3/34; H02M 3/10;

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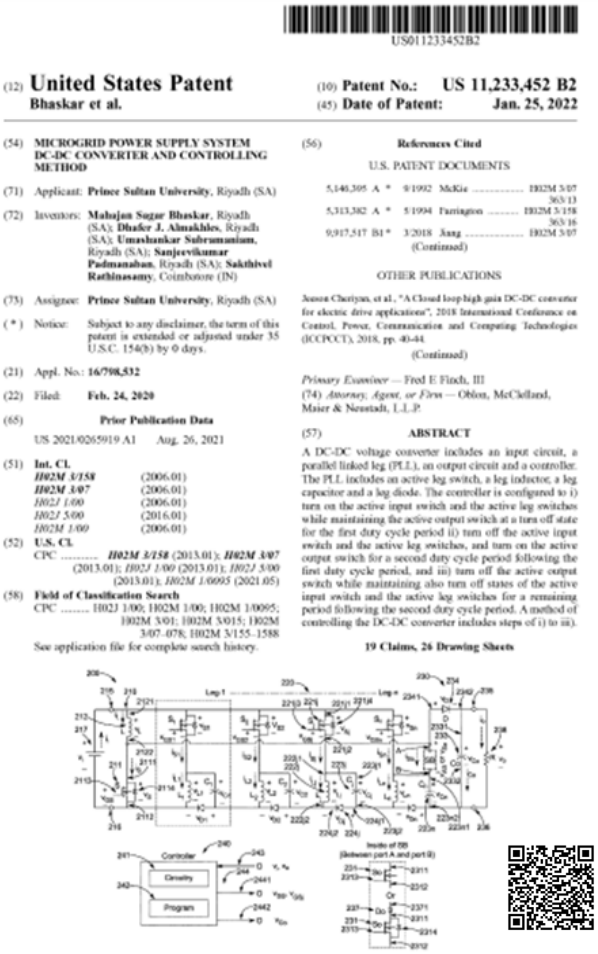
Vavilpalli et al., A Buck-Chopper Based Energy Storage System for the Cascaded H-Bridge Inverters in PV Applications, 2017, pp. 534-541 (Year: 2017).*

(57) **ABSTRACT**

A cascaded H-bridge (CHB) inverter for higher rated power conditioning systems which operates at medium voltages while providing high power quality and low dv/dt. By incorporating battery energy storage, the power conditioning system operates at night to provide power to a load or grid and stabilizes the system during sudden changes in climatic conditions. Various energy storage system (ESS) configurations such as AC side coupled ESS, dual active bridge based ESS, and chopper based ESS configurations for cascaded H-bridge inverters are described. A comparison of these configurations on the basis of cost, control complexity, controller hardware requirements was performed and the advantages of chopper based ESS configurations over other ESS configurations was demonstrated. A control algorithm for the chopper based configurations was developed to operate the system in standalone and grid-connected modes of operation.

14 Claims, 35 Drawing Sheets



US011233452B2

(12) **United States Patent**

Bhaskar et al.

(10) **Patent No.: US 11,233,452 B2**

(45) **Date of Patent: Jan. 25, 2022**

(54) **MICROGRID POWER SUPPLY SYSTEM DC-DC CONVERTER AND CONTROLLING METHOD**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventors: **Mahajan Sagar Bhaskar**, Riyadh (SA); **Dhafer J. Almakhles**, Riyadh (SA); **Umashankar Subramaniam**, Riyadh (SA); **Sanjeevikumar Padmanaban**, Riyadh (SA); **Sakthivel Rathinasamy**, Coimbatore (IN)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/798,532**

(22) Filed: **Feb. 24, 2020**

(65) **Prior Publication Data**

US 2021/0265919 A1 Aug. 26, 2021

(51) **Int. Cl.**

H02M 3/158 (2006.01)

H02M 3/07 (2006.01)

H02J 1/00 (2006.01)

H02J 5/00 (2016.01)

H02M 1/00 (2006.01)

(52) **U.S. Cl.**

CPC ***H02M 3/158*** (2013.01); ***H02M 3/07*** (2013.01); *H02J 1/00* (2013.01); *H02J 5/00* (2013.01); *H02M 1/0095* (2021.05)

(58) **Field of Classification Search**

CPC H02J 1/00; H02M 1/00; H02M 1/0095; H02M 3/01; H02M 3/015; H02M 3/07–078; H02M 3/155–1588

See application file for complete search history.

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Primary Examiner — Fred E Finch, III

(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A DC-DC voltage converter includes an input circuit, a parallel linked leg (PLL), an output circuit and a controller. The PLL includes an active leg switch, a leg inductor, a leg capacitor and a leg diode. The controller is configured to i) turn on the active input switch and the active leg switches while maintaining the active output switch at a turn off state for the first duty cycle period ii) turn off the active input switch and the active leg switches, and turn on the active output switch for a second duty cycle period following the first duty cycle period, and iii) turn off the active output switch while maintaining also turn off states of the active input switch and the active leg switches for a remaining period following the second duty cycle period. A method of controlling the DC-DC converter includes steps of i) to iii).

19 Claims, 26 Drawing Sheets

US 20210088337A1

(19) **United States**

(12) **Patent Application Publication**

KOUBAA

(10) **Pub. No.: US 2021/0088337 A1**

(43) **Pub. Date: Mar. 25, 2021**

(54) **SYSTEM AND METHOD FOR SERVICE ORIENTED CLOUD BASED MANAGEMENT OF INTERNET OF DRONES**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventor: **Anis KOUBAA**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(21) Appl. No.: **16/790,233**

(22) Filed: **Feb. 13, 2020**

Related U.S. Application Data

(60) Provisional application No. 62/903,277, filed on Sep. 20, 2019.

Publication Classification

(51) **Int. Cl.**

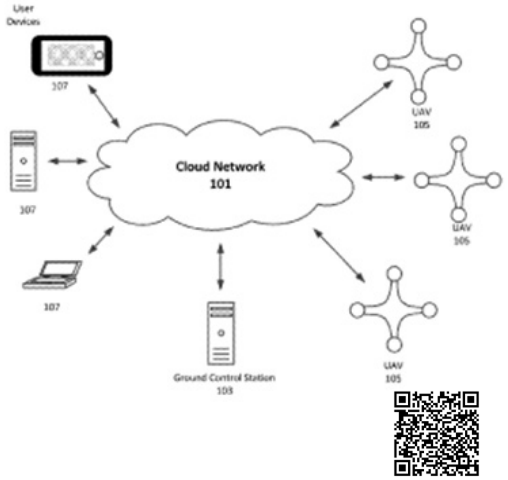
G01C 21/20	(2006.01)
H04L 29/08	(2006.01)
H04L 29/12	(2006.01)
G08G 5/00	(2006.01)
G08G 5/04	(2006.01)
B64C 39/02	(2006.01)
G05D 1/00	(2006.01)
G05D 1/10	(2006.01)

(52) **U.S. Cl.**

CPC ***G01C 21/20*** (2013.01); ***H04L 67/10*** (2013.01); ***H04L 67/12*** (2013.01); ***H04L 61/2007*** (2013.01); ***H04L 67/306*** (2013.01); ***G08G 5/0069*** (2013.01); *B64D 47/08* (2013.01); ***B64C 39/024*** (2013.01); ***G05D 1/0022*** (2013.01); ***G05D 1/1064*** (2019.05); *B64C 2201/027* (2013.01); *B64C 2201/126* (2013.01); *B64C 2201/146* (2013.01); ***G08G 5/045*** (2013.01)

(57) **ABSTRACT**

A Internet protocol-based unmanned aerial vehicle (UAV) management system and method is disclosed that includes UAVs including a communication chip, a user computer, a cloud-based service for performing a virtual UAV. The method includes storing a plurality of pre-planned missions, controlling communication between the UAV and the user computer, mapping the UAV to the virtual UAV, assigning a mission to include multiple waypoints, and allocating the task of the multiple waypoints. Dynamic mission planning of the assigned mission is performed to generate planned paths for performing the task. Operation of the UAV is controlled by way of the corresponding virtual UAV including receiving messages and commands for the mission from the user computer, sending control commands to the UAV, receiving data signals from the UAV, and transmitting location and status of performance of the task for the UAV. The cloud-based service performs image processing using the received data signals.



US011334065B2

(12) **United States Patent**

Koubaa et al.

(10) **Patent No.: US 11,334,065 B2**

(45) **Date of Patent: May 17, 2022**

(54) **SYSTEM, APPARATUS, AND METHOD FOR CONTROLLING UNMANNED AERIAL VEHICLES FOR SEARCH AND RESCUE**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventors: **Anis Koubaa**, Riyadh (SA); **Ebtehal Turki Alotaibi**, Riyadh (SA); **Shahad Saleh Alqefari**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 289 days.

(21) Appl. No.: **16/740,042**

(22) Filed: **Jan. 10, 2020**

(65) **Prior Publication Data**

US 2021/0216069 A1 Jul. 15, 2021

(51) **Int. Cl.**

G05D 1/00	(2006.01)
H04L 67/10	(2022.01)

(Continued)

(52) **U.S. Cl.**

CPC ***G05D 1/0027*** (2013.01); ***B64C 39/024*** (2013.01); ***G05D 1/104*** (2013.01); ***H04L 67/10*** (2013.01); ***H04W 4/90*** (2018.02); *B64C 2201/027* (2013.01); *B64C 2201/126* (2013.01); *B64C 2201/143* (2013.01)

(58) **Field of Classification Search**

USPC 701/20, 3, 50, 101; 340/902

See application file for complete search history.

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(Continued)

Primary Examiner — Elaine Gort

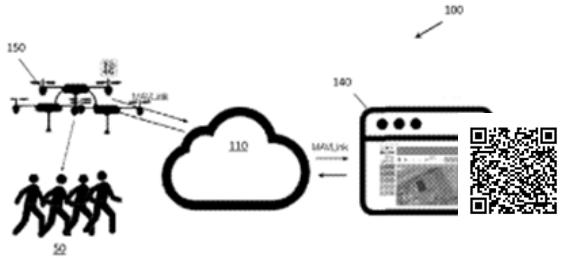
Assistant Examiner — Ellis B. Ramirez

(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A system, method, and non-transitory computer-readable storage medium to perform a search and rescue mission according to a Layered Search and Rescue (LSAR) methodology using a plurality of Unmanned Aerial Vehicles (UAVs) communicatively connected to a remote server. The LSAR methodology can involve receiving data corresponding to a center of an area corresponding to an adverse disaster event potentially having survivors at unknown locations; dividing the area into a set of numbered box-shaped layers within the area; calculating a thickness of the box-shaped layers based on a total number of the Unmanned Aerial Vehicles; exclusively assigning one or more of the Unmanned Aerial Vehicles to each box-shaped layer; and controlling the Unmanned Aerial Vehicles to perform the search and rescue mission by selectively switching one or more of the Unmanned Aerial Vehicles between a searcher mode and a rescuer mode.

20 Claims, 10 Drawing Sheets



US 20210209956A1

(19) **United States**

(12) **Patent Application Publication**

Allouche et al.

(10) **Pub. No.: US 2021/0209956 A1**

(43) **Pub. Date: Jul. 8, 2021**

(54) **BLOCKCHAIN-BASED SOLUTION FOR INTERNET OF DRONES SECURITY AND PRIVACY**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventors: **Azza Allouche**, Riyadh (SA); **Anis Koubaa**, Riyadh (SA); **Mohamed Khalgui**, Riyadh (SA); **Omar Cheikhrouhou**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(21) Appl. No.: **16/733,451**

(22) Filed: **Jan. 3, 2020**

Publication Classification

(51) **Int. Cl.**

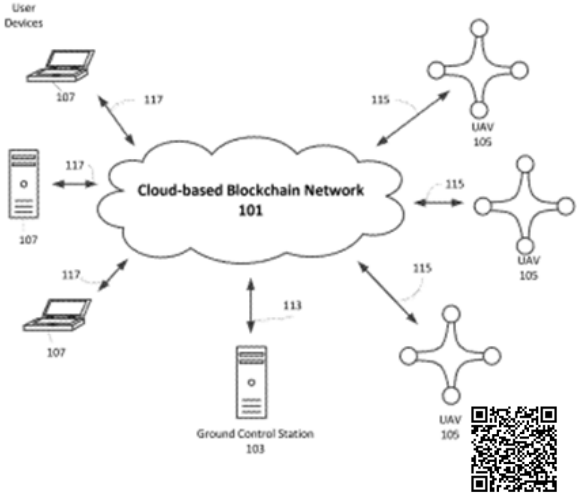
G08G 5/00	(2006.01)
H04L 29/06	(2006.01)
H04L 29/08	(2006.01)
G05D 1/00	(2006.01)
B64C 39/02	(2006.01)
G06F 16/23	(2006.01)

(52) **U.S. Cl.**

CPC ***G08G 5/0095*** (2013.01); ***H04L 63/123*** (2013.01); ***H04L 67/1097*** (2013.01); ***G05D 1/0011*** (2013.01); *H04L 67/02* (2013.01); ***G08G 5/0069*** (2013.01); ***G08G 5/0013*** (2013.01); ***G06F 16/2379*** (2019.01); ***B64C 39/024*** (2013.01)

(57) **ABSTRACT**

A secure system for control of at least one unmanned aerial vehicle (UAV), includes a cloud service and a ground control station. The cloud service includes a cloud-based management service having processing circuitry configured to control communications between the cloud service, the ground control station and the at least one UAV, and control and monitor the at least one UAV by way of a corresponding at least one UAV client device. The UAV client device receives messages from the at least one UAV, sends commands to the at least one UAV, verifies the sender of each of the received messages, creates a new block for each received message and sent commands as new transactions, including performs a consensus algorithm for the new block, determines a consensus to validate the new block, and updates a blockchain with the validated new block.



US011102698B2

(12) **United States Patent**
Tounsi

(10) **Patent No.: US 11,102,698 B2**
(45) **Date of Patent: Aug. 24, 2021**

(54) **TABU NODE SELECTION WITH MINIMUM SPANNING TREE FOR WSNS**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventor: **Mohamed Tounsi**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 46 days.

(21) Appl. No.: **16/729,893**

(22) Filed: **Dec. 30, 2019**

(65) **Prior Publication Data**

US 2021/0204190 A1 Jul. 1, 2021

(51) **Int. Cl.**

H04W 40/10	(2009.01)
H04W 84/18	(2009.01)
H04W 40/24	(2009.01)
H04L 12/721	(2013.01)
H04W 4/38	(2018.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04W 40/10*** (2013.01); ***H04L 45/127*** (2013.01); ***H04L 45/48*** (2013.01); ***H04W 4/38*** (2018.02); ***H04W 40/246*** (2013.01); ***H04W 40/28*** (2013.01); ***H04W 84/18*** (2013.01)

(58) **Field of Classification Search**

CPC H04W 40/00–10; H04W 40/24–32; H04W 4/30–48; H04W 84/18–22; H04W 52/04; H04W 52/06; H04W 52/18; H04W 52/38; H04L 12/462; H04L 45/00;

(Continued)

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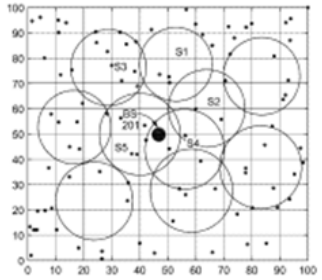
(Continued)

Primary Examiner — Warner Wong
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A wireless sensor network node selection that efficiently manages active nodes using a Tabu heuristic coupled with minimum spanning tree routing protocol (TNS-MST) is presented. Nodal energy consumption is balanced to ensure all nodes are operating at the same energy level. To balance the energy consumption, nodes with high energy depletion are removed from routing by placing on them a Tabu list, which prevents the most used nodes, such as nodes close to a base station, from draining before their neighbors. The nodes in the Tabu lists are dynamically active according to the energy level of neighboring nodes. The Tabu list combined with Minimum Spanning Tree routing protocol, TNS-MST, greatly increases network lifetime by optimally balancing the energy of the sensor nodes.

18 Claims, 21 Drawing Sheets



US010297353B1

(12) **United States Patent**
Al-Matouq

(10) **Patent No.: US 10,297,353 B1**
(45) **Date of Patent: May 21, 2019**

(54) **ESTIMATION OF GLUCOSE RATE OF APPEARANCE, ENDOGENOUS GLUCOSE PRODUCTION AND INSULIN DEPENDENT GLUCOSE UTILIZATION FROM CONTINUOUS GLUCOSE SENSORS AND SUBCUTANEOUS INSULIN DELIVER**

(71) Applicant: **Prince Sultan University**, Riyadh (SA)

(72) Inventor: **Ali Ahmed Al-Matouq**, Riyadh (SA)

(73) Assignee: **Prince Sultan University**, Riyadh (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/974,451**

(22) Filed: **May 8, 2018**

(51) **Int. Cl.**

G16H 50/50	(2018.01)
A61B 5/00	(2006.01)
A61B 5/145	(2006.01)
A61M 5/172	(2006.01)

(52) **U.S. Cl.**

CPC ***G16H 50/50*** (2018.01); ***A61B 5/14532*** (2013.01); ***A61B 5/4839*** (2013.01); *A61B 5/0002* (2013.01); *A61B 5/7271* (2013.01); *A61M 5/1723* (2013.01); *A61M 2205/52* (2013.01)

(58) **Field of Classification Search**

CPC .. G16H 50/50; A61B 5/14532; A61B 5/4839; A61B 5/0002; A61B 5/7271; A61M 5/1723; A61M 2205/52

USPC 340/573.1; 604/506; 600/365

See application file for complete search history.

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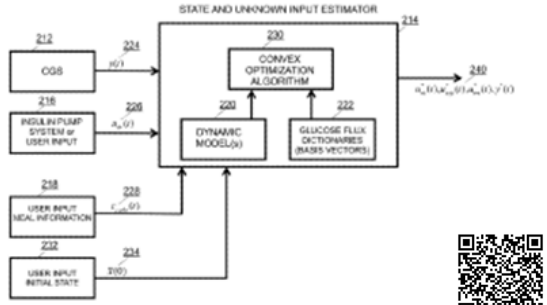
Primary Examiner — Jack K. Wang
(74) *Attorney, Agent, or Firm* — Steven M. Shape, Dennemeyer & Associates, LLC

(57) **ABSTRACT**

Method and system for determining glucose flux profiles in plasma during meals using continuous glucose sensors and insulin delivery. A database of plausible glucose flux profiles is encoded in dictionaries using sparse dictionary learning. A constrained Lasso minimization problem is formed that integrates a transport model for a patient with the dictionaries for estimating the glucose fluxes. Meal carbohydrates consumed by a patient is incorporated in the minimization problem through convex constraints. The estimated glucose fluxes resulting from solving the constrained Lasso minimization problem are glucose rate of appearance from the intestine, endogenous glucose production from the liver and insulin dependent glucose utilization. A method for determining patient carbohydrate to insulin ratio at the time of the meal by calculating the area under the curve of the estimated insulin dependent glucose utilization.

16 Claims, 7 Drawing Sheets



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
31 August 2017 (31.08.2017)

WIPO | PCT

(10) **International Publication Number**
WO 2017/145119 A1

(51) **International Patent Classification**:
A61B 5/00 (2006.01) *G06F 19/00* (2011.01)
A61B 5/145 (2006.01)

(21) **International Application Number**:
PCT/IB2017/051100

(22) **International Filing Date**:
24 February 2017 (24.02.2017)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
62/300,426 26 February 2016 (26.02.2016) US
62/300,438 26 February 2016 (26.02.2016) US

(71) **Applicants**: **KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY** [SA/SA]; 4700 King Abdullah University of Science and Technology, Thuwal 23955-6900 (SA). **PRINCE SULTAN UNIVERSITY** [SA/SA]; Mansur Ibn Muhammad, Salah Ad Din, Riyadh 12435 (SA).

(72) **Inventors**: **LALEG, Taous Meriem**; 4700 King Abdullah University of Science and Technology, Thuwal 23955-6900 (SA). **AL-MATOUQ, Ali Ahmed**; Mansur Ibn Muhammad, Salah Ad Din, Riyadh 12435 (SA).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:
— *with international search report (Art. 21(3))*

(54) **Title**: ESTIMATION OF GLUCOSE RATE OF APPEARANCE FROM CGS AND SUBCUTANEOUS INSULIN DELIVERY IN TYPE 1 DIABETES

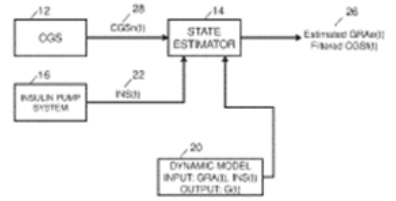


FIG. 1

(57) **Abstract**: Method and System for providing estimates of Glucose Rate of Appearance from the intestine (GRA) using continuous glucose sensor measurements (CGS) taken from the subcutaneous of a diabetes patient and the amount of insulin administered to the patient.

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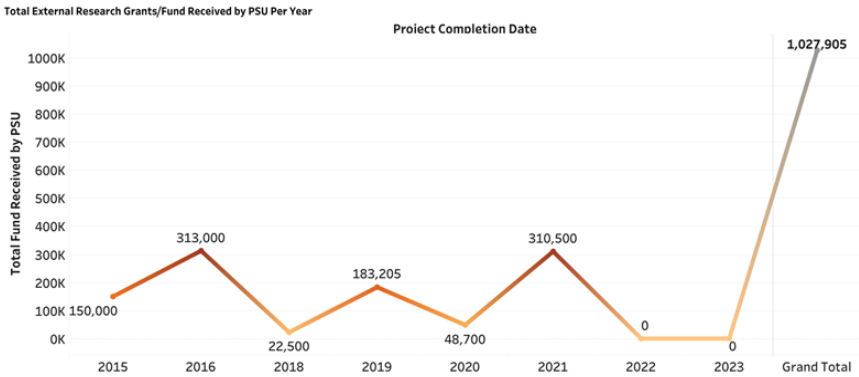
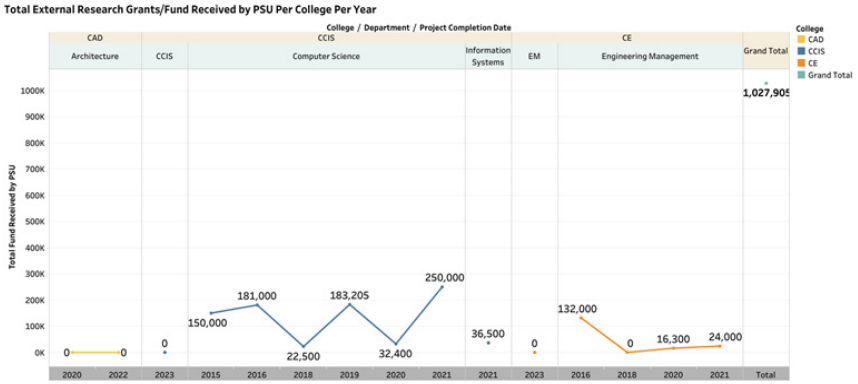
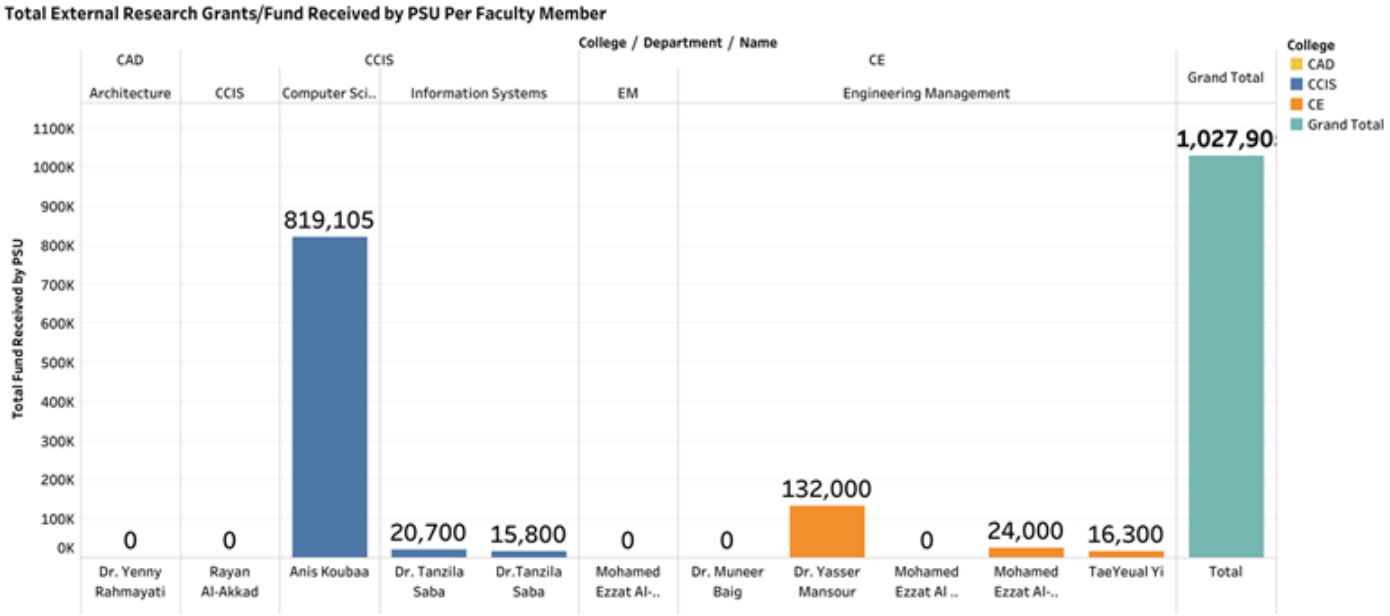
External grants

PSU faculty were able to secure external grants from academia and industry.







Innovation

RIC launched the business incubator program. A memorandum of understanding was signed with i-be Business Hub in September to encourage entrepreneurship among students. Two startups are enrolled in the program.

Source: 2021 RIC report

Collaboration with industry

Trimble Signs MOU with Prince Sultan University (Oct. 2021)

Trimble Signs MOU with Prince Sultan University

October 04,2021

Prince Sultan University (PSU) in Riyadh, Saudi Arabia, and **Trimble Inc. (NASDAQ: TRMB)** have recently signed a memorandum of understanding (MOU). The purpose of this MOU is to set forth increased collaboration and cooperation between the College of Engineering at PSU and Trimble to educate the students with advanced 3D BIM Tekla Solutions used in the construction world.

VMware MoU Ceremony

June 08,2021

Signing of a cooperation agreement between Prince Sultan Schneider Electric University

September 28,2021

SUSTAINABLE DEVELOPMENT GOALS

PSU's commitment to SDG 2030

PSU is committed to United Nations Sustainable Development Goals (SDGs) through effective institutional resource management, innovative teaching and learning, research, national and international partnerships, continuous studies, and outreach. PSU shall undertake the following activities: form higher and steering committees, evaluate each SDG, formulate and develop related SDG policies, conduct awareness campaigns to the PSU community, establish a sustainability office, identify the SDGs related to each college, program, and course, and lab centers at PSU, and mplement sustainability-related initiatives.

Vision

Prince Sultan University strives to support Saudi Arabia's Vision 2030 and the United Nations Sustainable Development Goals (SDGs) by paving the way for higher education in KSA and Middle East.

Mission

Supporting the Saudi Arabia's Vision 2030 and the PSU's strategic directions, PSU aligns its mission with SDGs by providing quality education, sustainability initiatives, lifelong learning, scientific research, and community service.

جامعة الأمير سلطان
PRINCE SULTAN UNIVERSITY

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