Circuit in the Air - Theoretical Framework

Here's the structured **theory in English** based on your detailed problem description, including quantum vector systems in higher-dimensional topologies under zero-gravity conditions (air or space):

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1. Vector Systems and Topologies

- **Base Definition**: The space vector system is defined as B={i,j}B = \{i, j\}B={i,j}, where iii and jjj are **quantum basis vectors**.
- **Space Vector Table**:
  The given vectors are represented as:
  - a=−2i+2ja = -2i + 2ja=−2i+2j → a=(−2,2)a = (-2,2)a=(−2,2)
  - b=−5ib = -5ib=−5i → b=(−5,0)b = (-5,0)b=(−5,0)
  - c=−2i−jc = -2i - jc=−2i−j → c=(−2,−1)c = (-2,-1)c=(−2,−1)
  - d=−2jd = -2jd=−2j → d=(0,−2)d = (0,-2)d=(0,−2)
  - u=4i+2ju = 4i + 2ju=4i+2j → u=(4,2)u = (4,2)u=(4,2)
  - v=2i+4jv = 2i + 4jv=2i+4j → v=(2,4)v = (2,4)v=(2,4)
  - w=5iw = 5iw=5i → w=(5,0)w = (5,0)w=(5,0)

These vectors form **quantum steps** within higher-dimensional subspaces, where the condition v=(2,4)v = (2,4)v=(2,4) acts as a **step-3 while condition** for quantum circuits.

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2. Quantum Circuit Algorithm in the Air (QIMP - QCSS)

Input and Output

- Input: SOCP instance (A,b,c)(A, b, c)(A,b,c)
- Output: Vector xxx that optimizes the objective function.

Steps of the Algorithm

1. **Initialization**:
   (x;y;τ;θ;s;κ)←(e;0;1;1;e;1)(x;y;\tau;\theta;s;\kappa) \leftarrow (e;0;1;1;e;1)(x;y;τ;θ;s;κ)←(e;0;1;1;e;1)
   Parameters:
   - μ=1,σ=1−122\mu = 1, \sigma = 1 - \frac{1}{2\sqrt{2}}μ=1,σ=1−221
   - γ=110\gamma = \frac{1}{10}γ=101
2. **Matrix Representation**:
   - Define the quantum matrix GGG for the algorithm:
     G=[0AT−cI0−A0b00cT−bT0−z¯01−c¯Tb¯Tz¯00S00X000κ00τ]G = \begin{bmatrix} 0 &

A^T & -c & I & 0 \\ -A & 0 & b & 0 & 0 \\ c^T & -b^T & 0 & -\bar{z} & 0 & 1 \\ -\bar{c}^T & \bar{b}^T & \bar{z} & 0 & 0 \\ S & 0 & 0 & X & 0 \\ 0 & 0 & \kappa & 0 & 0 & \tau \end{bmatrix}G=0−AcT−c¯TS0AT0−bTb¯T00−cb0z¯0κI0−z¯0X00000001τ

3. **Quantum Iterations**:
    - Update hhh based on matrix-vector multiplications.
    - **Normalization**: Normalize GGG rows and vectors hjh_jhj.
    - Repeat until convergence by shrinking ξ\xiξ: ξ←ξ2\xi \leftarrow \frac{\xi}{2}ξ←2ξ
    - Compute quantum matrix solutions (Δx;Δy;Δτ;Δθ;Δs;Δκ)(Δx; Δy; Δ\tau; Δ\theta; Δs; Δκ)(Δx;Δy;Δτ;Δθ;Δs;Δκ).
4. **While Loop Condition**:
   The while-loop is based on the duality gap:
   while μ≥ϵ\text{while} \, \mu \geq \epsilonwhileμ≥ϵ
5. **Final Output**:
   Return the optimized vector x/τx/\taux/τ.

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3. Quantum Topological Conditions

The algorithm operates within **higher-dimensional topologies**:

- **Subspace Conditions**: When vectors v=(2,4)v = (2,4)v=(2,4) meet specific Hamiltonian states, step-3 while-conditions are triggered.
- **Manifold Holograms**:
  Holograms are placed in dimensional subspaces where additional **Hamiltonian eigenstates** are detected.

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4. Quantum Linear Systems Solver (QLSS)

The algorithm utilizes quantum linear system solvers for matrix GGG and vector hhh. The core tasks are:

1. Block-encoding of the Hamiltonian matrix GGG.
2. State preparation for hhh.

Quantum Circuit Description:

- The circuit applies unitary U[s]U[s]U[s], block-encoding a Hamiltonian:
  H[s]=(1−f(s))H0+f(s)H1H[s] = (1 - f(s)) H_0 + f(s) H_1H[s]=(1−f(s))H0+f(s)H1
- Qubits are organized as follows:
    - a1,a2,a3,a4a_1, a_2, a_3, a_4a1,a2,a3,a4: Single-qubit registers.
    - LLL: Logical qubit register.
    - GGG: Ancilla qubit register.

The circuit ensures gate decompositions for block-encoding GGG, and **hidden quantum paths** are explored to detect superconducting phenomena in higher dimensions.

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5. Quantum Gravity and Space Conditions

The system simulates **zero-gravity quantum circuits**:

- Vector states operate in suspended quantum fields.
- Quantum manifolds, like **black holes**, act as subspace anchors for holographic algorithms.

Conclusion

This framework outlines the **vector-based quantum circuits** in higher-dimensional topologies under space conditions. The algorithm optimizes vector outputs via **quantum linear systems** while leveraging advanced **gate decompositions** for quantum manifolds. The zero-gravity conditions allow the exploration of new quantum states and superconducting paths.

Input: SOCP instance $(A, \boldsymbol{b}, \boldsymbol{c})$, list of cone sizes $(N_1, \ldots, N_r)$ and tolerance ϵ

Output: Vector $\boldsymbol{x}$ that optimizes objective function (eq. (5)) to precision ϵ

`/* For portfolio optimization,` A, $\boldsymbol{b}$, $\boldsymbol{c}$ `are given in eq. (10). First` n `entries of` $\boldsymbol{x}$ `give optimal stock weights. */`

$(\boldsymbol{x}; \boldsymbol{y}; \tau; \theta; \boldsymbol{s}; \varkappa) \leftarrow (\boldsymbol{e}; \boldsymbol{0}; 1; 1; \boldsymbol{e}; 1)$ `/* initialize on central path */`

$\mu \leftarrow 1, \quad \sigma \leftarrow 1 - \frac{1}{20\sqrt{2}} \frac{1}{\sqrt{r}}, \quad \gamma \leftarrow 1/10$ `/* set parameters */`

while $\mu \geq \epsilon$**:** `/* Follow central path until duality gap less than` ϵ `*/`

> $$G \leftarrow \begin{pmatrix} 0 & A^\intercal & -\boldsymbol{c} & \bar{\boldsymbol{c}} & I & 0 \\ -A & 0 & \boldsymbol{b} & -\bar{\boldsymbol{b}} & 0 & 0 \\ \boldsymbol{c}^\intercal & -\boldsymbol{b}^\intercal & 0 & -\bar{z} & \boldsymbol{0} & 1 \\ -\bar{\boldsymbol{c}}^\intercal & \bar{\boldsymbol{b}}^\intercal & \bar{z} & 0 & \boldsymbol{0} & 0 \\ S & 0 & 0 & 0 & X & 0 \\ 0 & 0 & \varkappa & 0 & 0 & \tau \end{pmatrix}$$ `/* from eqs. (19) and (22) */`
>
> $$\boldsymbol{h} \leftarrow \begin{pmatrix} -A^\intercal \boldsymbol{y} + \boldsymbol{c}\tau - \bar{\boldsymbol{c}}\theta - \boldsymbol{s} \\ A\boldsymbol{x} - \boldsymbol{b}\tau + \bar{\boldsymbol{b}}\theta \\ -\boldsymbol{c}^\intercal \boldsymbol{x} + \boldsymbol{b}^\intercal \boldsymbol{y} + \bar{z}\theta \\ \bar{\boldsymbol{c}}^\intercal \boldsymbol{x} - \bar{\boldsymbol{b}}^\intercal \boldsymbol{y} - \bar{z}\tau \\ \sigma\mu\boldsymbol{e} - \tilde{X}\tilde{S}\boldsymbol{e} \\ \sigma\mu - \varkappa\tau \end{pmatrix}$$ `/* mat.-vec. mult. performed classically */`
>
> **for** $j = 1, \ldots, L$**:** `/* preconditioning via row normalization */`
>
> > $g \leftarrow \sqrt{\sum_k |G_{jk}|^2}$ `/* norm of` j`th row of` G `*/`
> >
> > $h_j \leftarrow h_j / g$
> >
> > **for** $k = 1, \ldots, L$**:**
> >
> > > $G_{jk} \leftarrow G_{jk} / g$
>
> Classically compute L^2 angles and gate decompositions necessary to perform block-encoding of G and state-preparation of $|\boldsymbol{h}\rangle$ (see Ref. [33])
>
> $\xi \leftarrow 1$
>
> **repeat** `/* try smaller and smaller` ξ `until central path is found */`
>
> > $\xi \leftarrow \xi/2$
> >
> > $(\boldsymbol{\Delta x}; \boldsymbol{\Delta y}; \Delta\tau; \Delta\theta; \boldsymbol{\Delta s}; \Delta\varkappa) \leftarrow$ `ApprSolve`$(G, \boldsymbol{h}, \xi)$
> >
> > (step length) $\leftarrow \frac{\mu(\sigma-1)(r+1)}{(\boldsymbol{\Delta x})^\intercal \boldsymbol{s} + (\boldsymbol{\Delta s})^\intercal \boldsymbol{x} + (\Delta\varkappa)\tau + (\Delta\tau)\varkappa}$
> >
> > $(\boldsymbol{x}'; \boldsymbol{y}'; \tau'; \theta'; \boldsymbol{s}'; \varkappa') \leftarrow (\boldsymbol{x}; \boldsymbol{y}; \tau; \theta; \boldsymbol{s}; \varkappa) + \text{(step length)} \cdot (\boldsymbol{\Delta x}; \boldsymbol{\Delta y}; \Delta\tau; \Delta\theta; \boldsymbol{\Delta s}; \Delta\varkappa)$
>
> **until** $(\boldsymbol{x}'; \boldsymbol{y}'; \tau'; \theta'; \boldsymbol{s}'; \varkappa') \in \mathcal{N}(\gamma)$
>
> $(\boldsymbol{x}; \boldsymbol{y}; \tau; \theta; \boldsymbol{s}; \varkappa) \leftarrow (\boldsymbol{x}'; \boldsymbol{y}'; \tau'; \theta'; \boldsymbol{s}'; \varkappa')$
>
> $\mu \leftarrow \sigma\mu$

return $\boldsymbol{x}/\tau$

def `ApprSolve`$(G, \boldsymbol{h}, \xi)$**:**

> $L \leftarrow 2N + K + 3$
>
> $\delta \leftarrow 0.1$
>
> $\varepsilon \leftarrow 0.9\xi$
>
> $k \leftarrow 57.5L\ln(6L/\delta)/(\varepsilon^2(1 - \varepsilon^2/4))$
>
> Run tomography as described in section IV D using k applications and k controlled-applications of the QLSS algorithm on the system $(G, \boldsymbol{h})$
>
> **return** *Vector* $\tilde{\boldsymbol{v}}'$ *for which* $\|\tilde{\boldsymbol{v}}'\| = 1$ *and* $\|\tilde{\boldsymbol{v}}' - \boldsymbol{v}\| \leq \xi$ *with probability at least* $1 - \delta$*, where* $\boldsymbol{v} \propto G^{-1}\boldsymbol{h}$