

Utilization of Big Data in Motor Drive System base on Model Predictive Control

モデル予測制御に基づくモータ駆動システムにおけるビッグデータの活用

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Control Technology × Data Circulation

My Viewpoint

Utilizing Big Data for Control Algorithm

Content of steady in Program

- I have studied
 - How to focus attention on the data
 - How to handle the data through Real-World Data Circulation

Contribution fields of control technology

- Control technology supports many fields and products
- The multiplication of **Control Technology** and **Data Circulation** will create **New Value** from now on

My Research & Results

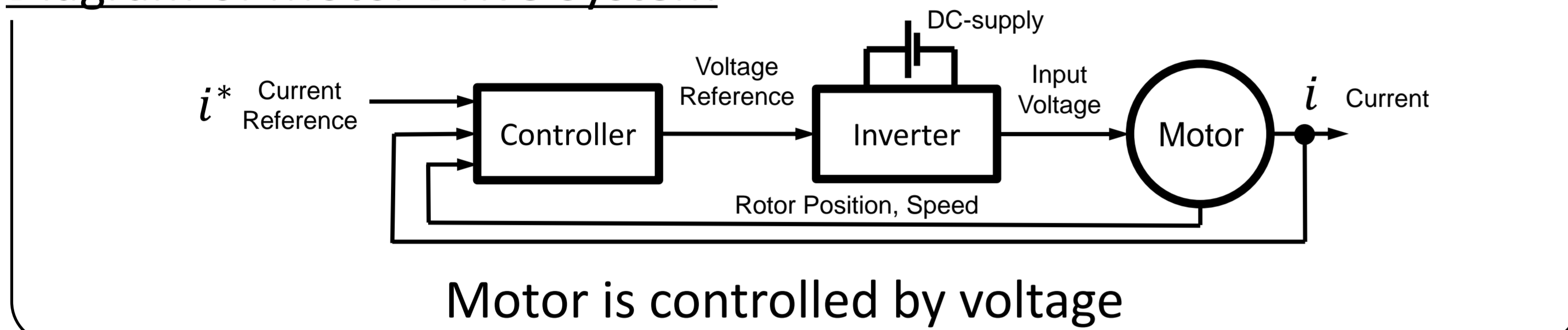
My research topic

The application of Model Predictive Control(MPC) for Motor Drive System

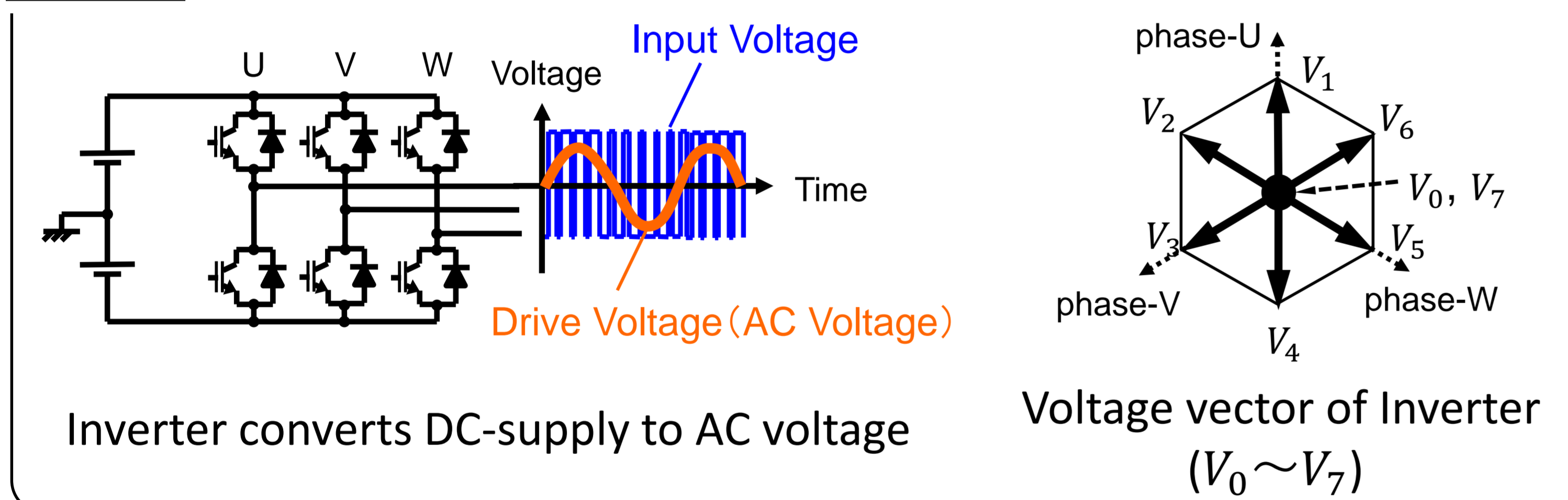
Motor Drive System

Important factors supporting the Modern life
 ex) Consumer Electronics, Electric Vehicle and etc.

Diagram of Motor Drive System



Inverter



How to decide Input Voltage

Conventional method

Controller calculates amplitude of drive voltage (v_{amp}) from the error between reference and sampled current

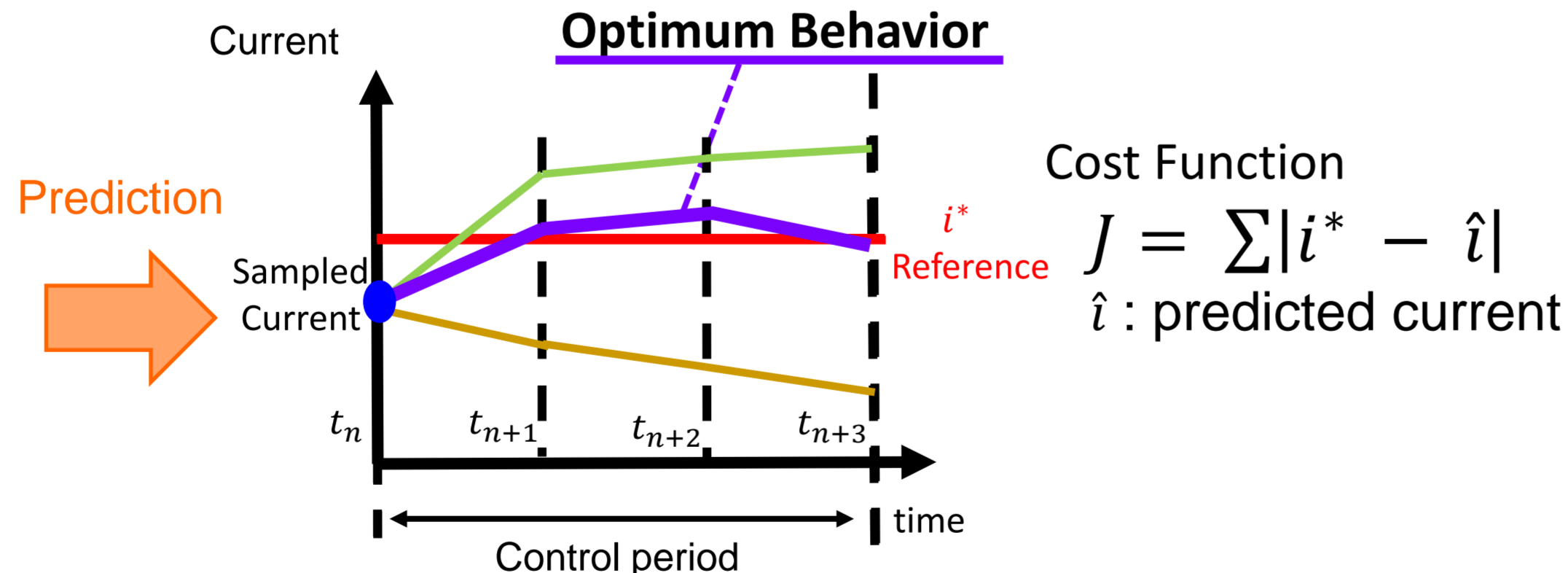
$$v_{amp} = K * (i^* - i) \quad K : \text{Gain}$$

MPC

Controller predicts **the future current behaviors** for vector combinations and **selects optimum input voltage** which cost function is minimum

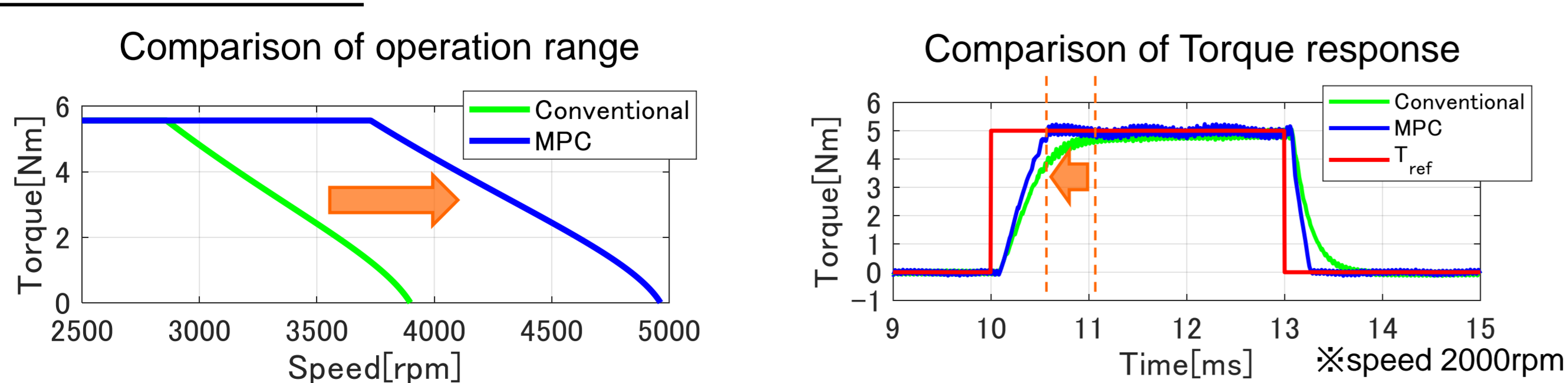
Combinations

- V_3, V_2, V_2
- V_1, V_2, V_7
- V_7, V_7, V_7



Optimum Control by prediction and evaluation

Simulation Results



MPC is effective for wider operation range and Faster response

Problem of MPC

Calculation amount of prediction is very huge

Number of Combinations is over thousands
 Prediction and evaluation time > control period (tens micro seconds)

➡ Implementation of MPC is impossible

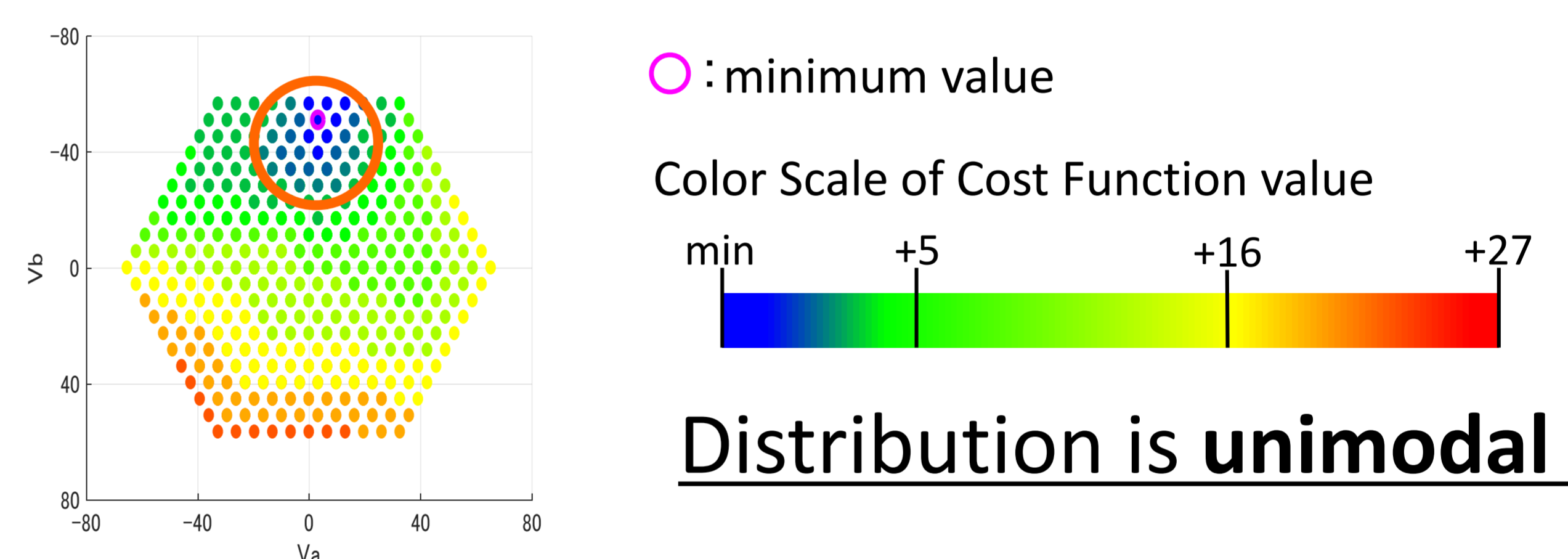
MPC needs to reduce calculation time for realization

I have been focusing on data utilization for reducing the calculation time of MPC

Data Utilization in MPC

The cost function distribution in voltage vector space

I paid attention to the relationship of **cost function value** and **voltage of each combination**



Controller can search optimum combination from the orange circle

Search space can be restrictable

Computational amount decreases due to space limitation

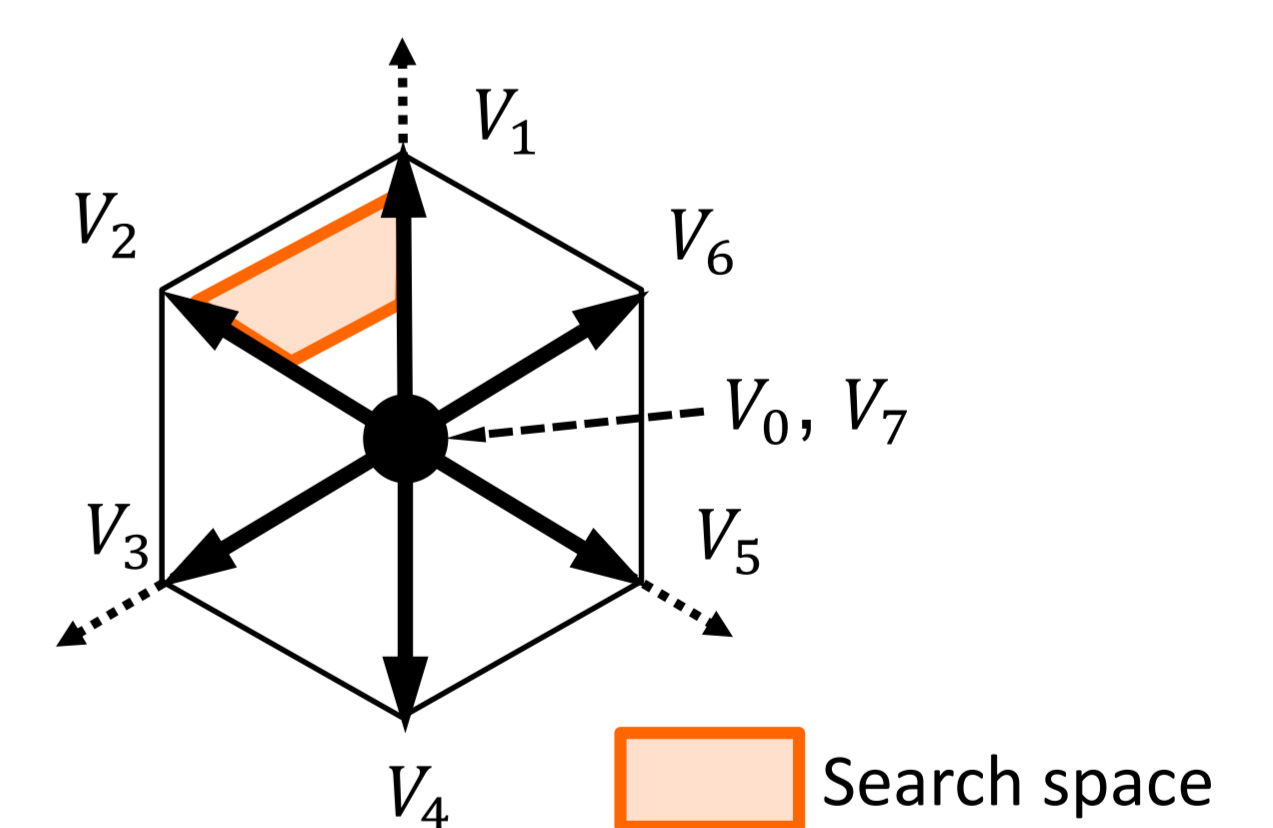
Propose limitation method for MPC

I have proposed the method to **limit the search space** by sensed driving situation

Sampled value

- Current
- Motor Speed
- Reference

Selecting Search space



Comparison in same condition

	Before space limit	After space limit
Simulation time	13.4h	24min
rate	100%	2.97%

Calculation time decrease by limiting the search space

Feasibility of MPC is improved

Future Plans of Doctoral dissertation

- Implementation of MPC for actual system
- Generalization of this method for other motors