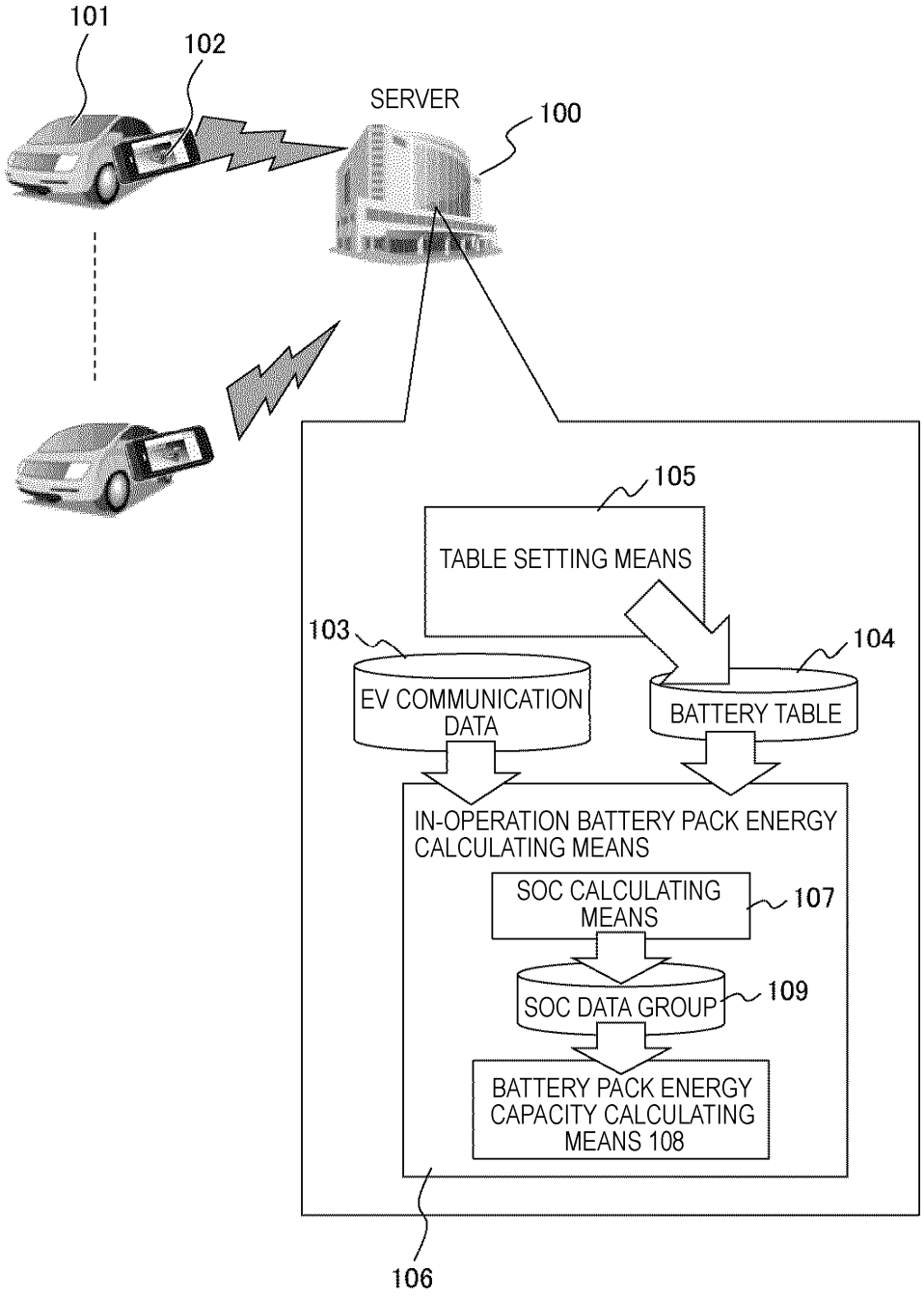
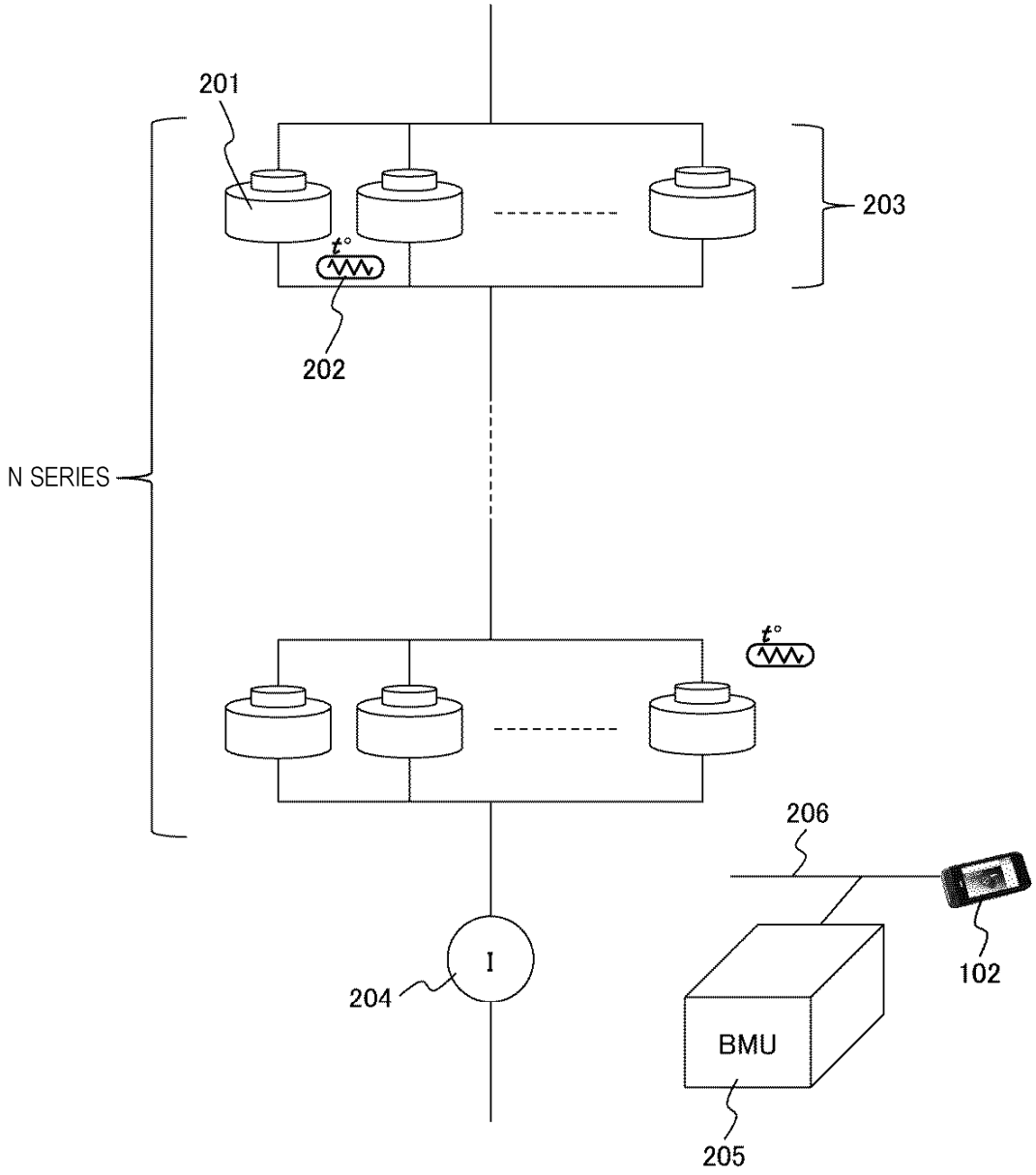
[FIG. 1]


101
102
SERVER
100
105
TABLE SETTING MEANS
103
104
EV COMMUNICATION DATA
BATTERY TABLE
IN-OPERATION BATTERY PACK ENERGY CALCULATING MEANS
SOC CALCULATING MEANS
107
SOC DATA GROUP
109
BATTERY PACK ENERGY CAPACITY CALCULATING MEANS 108
106

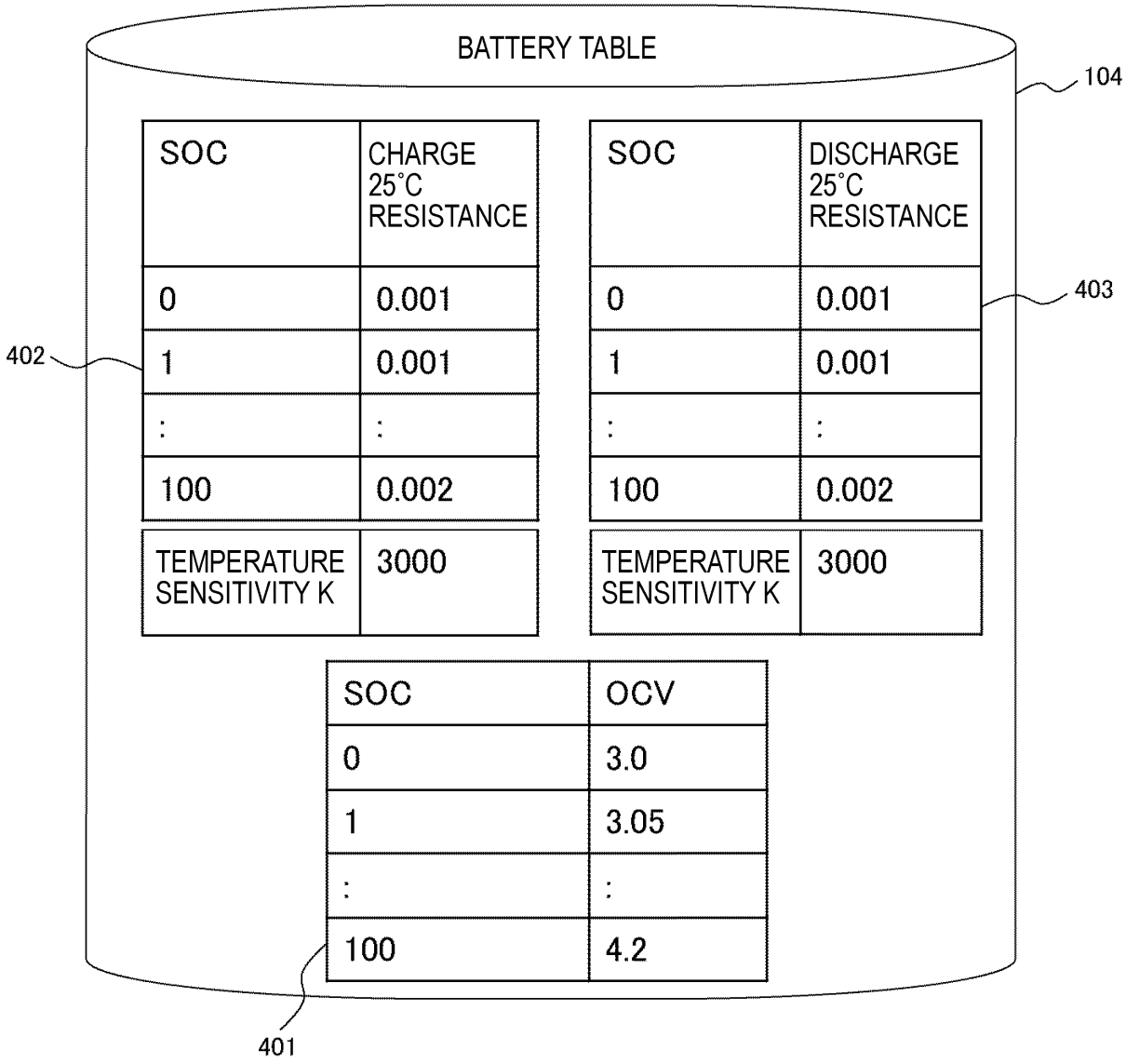
[FIG. 2]



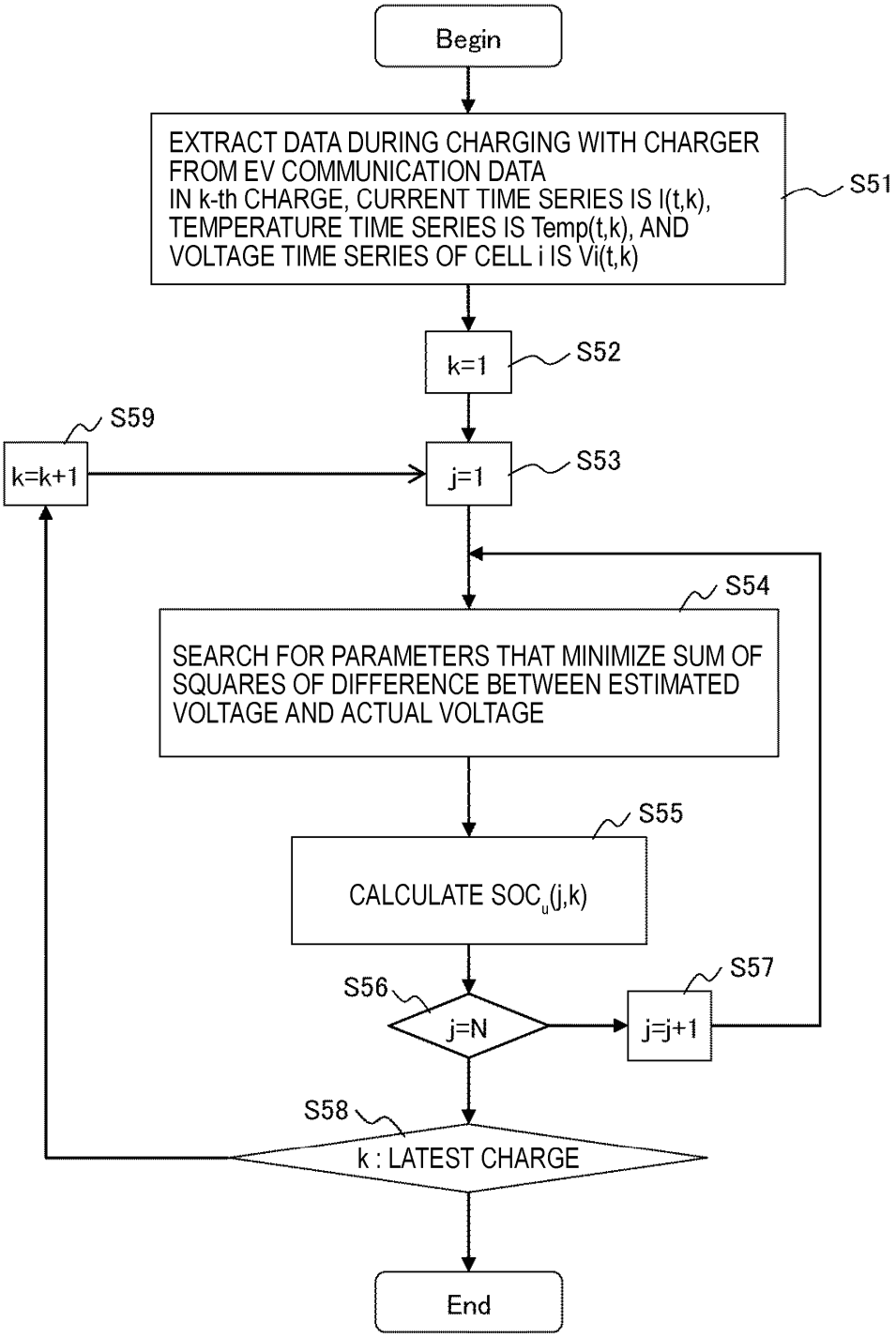
[FIG. 3]

No.	ITEM	VALUE
1	VEHICLE ID	123456
2	TIME	2020/1/1 10:7:6.0
3	POSITION (LONGITUDE, LATITUDE)	(36.5148224,140.6088105)
4	VEHICLE STATE FLAG	CHARGING
5	PACK CURRENT A (CHARGE +, DISCHARGE -)	10A
6	PACK SOC%	30
7	NUMBER OF SERIES N IN PACK	100
8	NUMBER OF TEMPERATURE SENSORS M IN PACK	10
9	PACK CATALOG Ah	40
10	PACK CATALOG kWh	30
11	BATTERY 1 VOLTAGE V	3.3
12	BATTERY 2 VOLTAGE V	3.31
:	:	:
N+10	BATTERY N VOLTAGE V	3.29
N+11	THERMOMETER 1 TEMPERATURE ˚C	25
:	:	:
N+M+10	THERMOMETER M TEMPERATURE ˚C	24.6

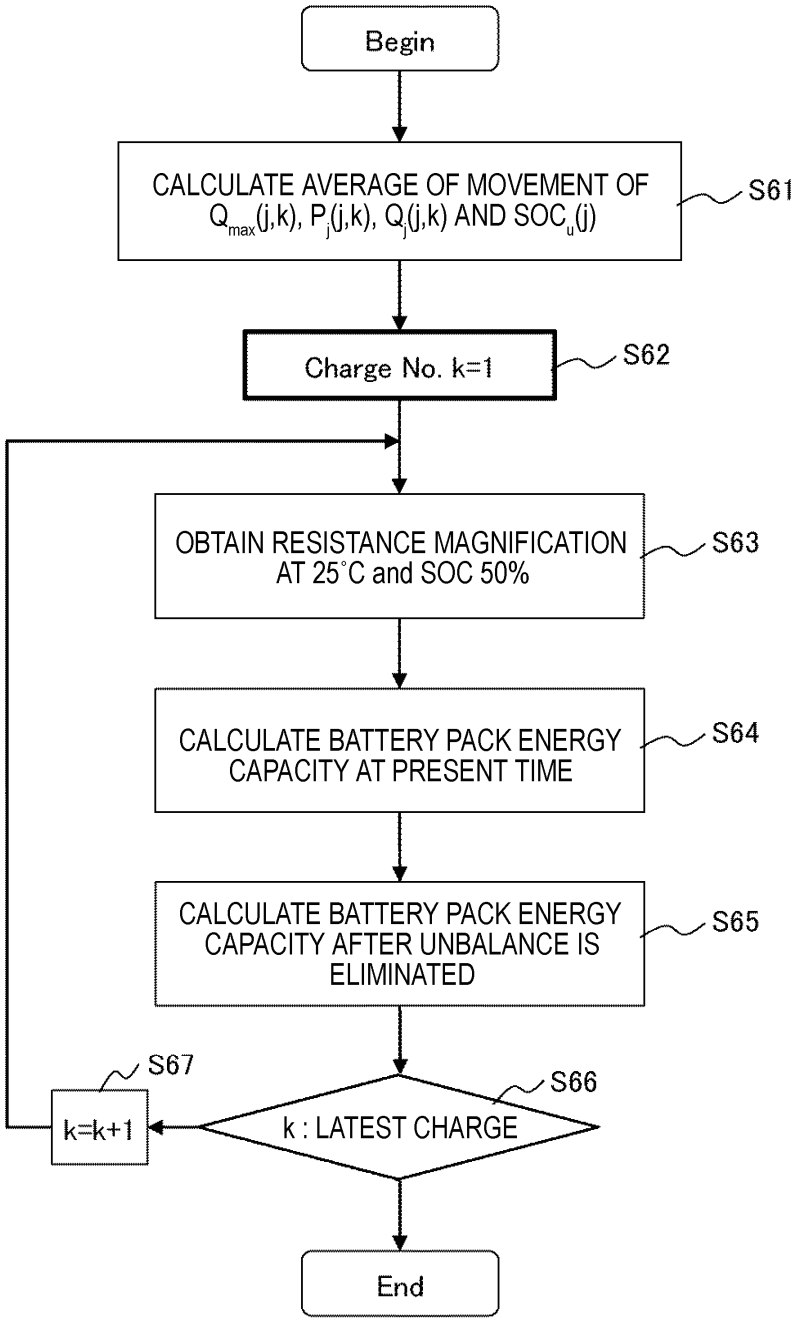
[FIG. 4]


BATTERY TABLE
104
SOC
CHARGE 25°C RESISTANCE
0
0.001
1
0.001
:
:
100
0.002
TEMPERATURE SENSITIVITY K
3000
SOC
DISCHARGE 25°C RESISTANCE
0
0.001
1
0.001
:
:
100
0.002
TEMPERATURE SENSITIVITY K
3000
SOC
OCV
0
3.0
1
3.05
:
:
100
4.2
402
403
401

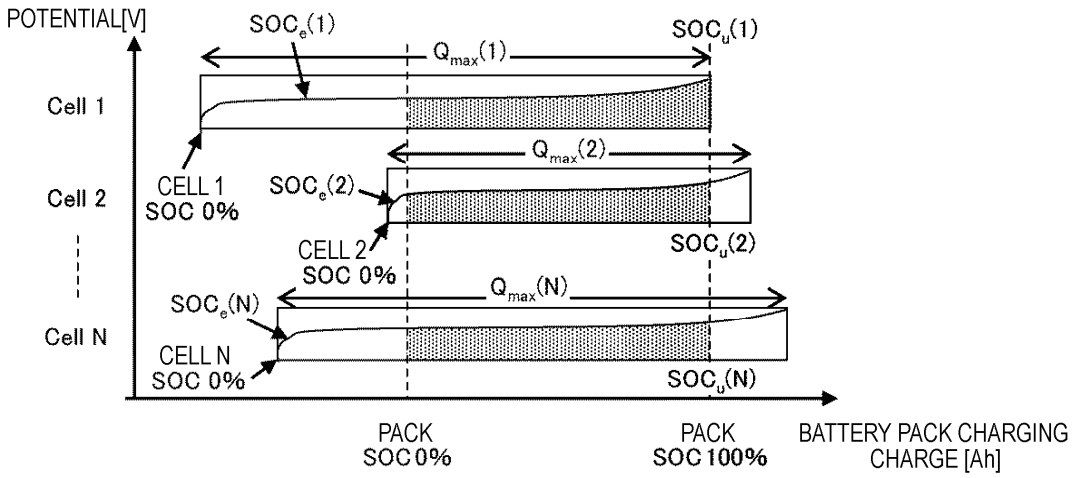
[FIG. 5]


Begin
EXTRACT DATA DURING CHARGING WITH CHARGER FROM EV COMMUNICATION DATA
IN k-th CHARGE, CURRENT TIME SERIES IS I(t,k), TEMPERATURE TIME SERIES IS Temp(t,k), AND VOLTAGE TIME SERIES OF CELL i IS Vi(t,k)
S51
k=1
S52
S59
k=k+1
j=1
S53
S54
SEARCH FOR PARAMETERS THAT MINIMIZE SUM OF SQUARES OF DIFFERENCE BETWEEN ESTIMATED VOLTAGE AND ACTUAL VOLTAGE
S55
CALCULATE SOC_u(j,k)
S56
j=N
S57
j=j+1
S58
k : LATEST CHARGE
End

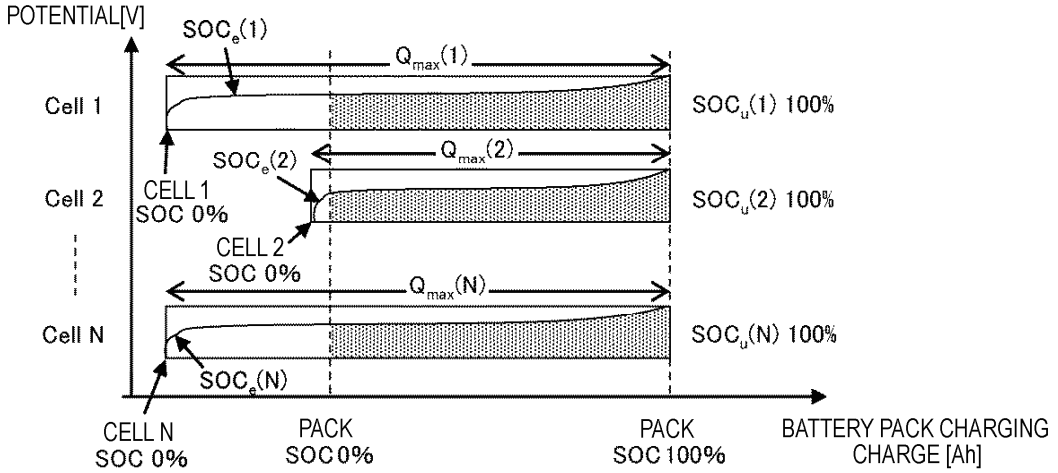
[FIG. 6]


Begin
CALCULATE AVERAGE OF MOVEMENT OF $Q_{max}(j,k)$, $P_j(j,k)$, $Q_j(j,k)$ AND $SOC_u(j)$
S61
Charge No. k=1
S62
OBTAIN RESISTANCE MAGNIFICATION AT 25°C and SOC 50%
S63
CALCULATE BATTERY PACK ENERGY CAPACITY AT PRESENT TIME
S64
CALCULATE BATTERY PACK ENERGY CAPACITY AFTER UNBALANCE IS ELIMINATED
S65
S66
k : LATEST CHARGE
S67
k=k+1
End

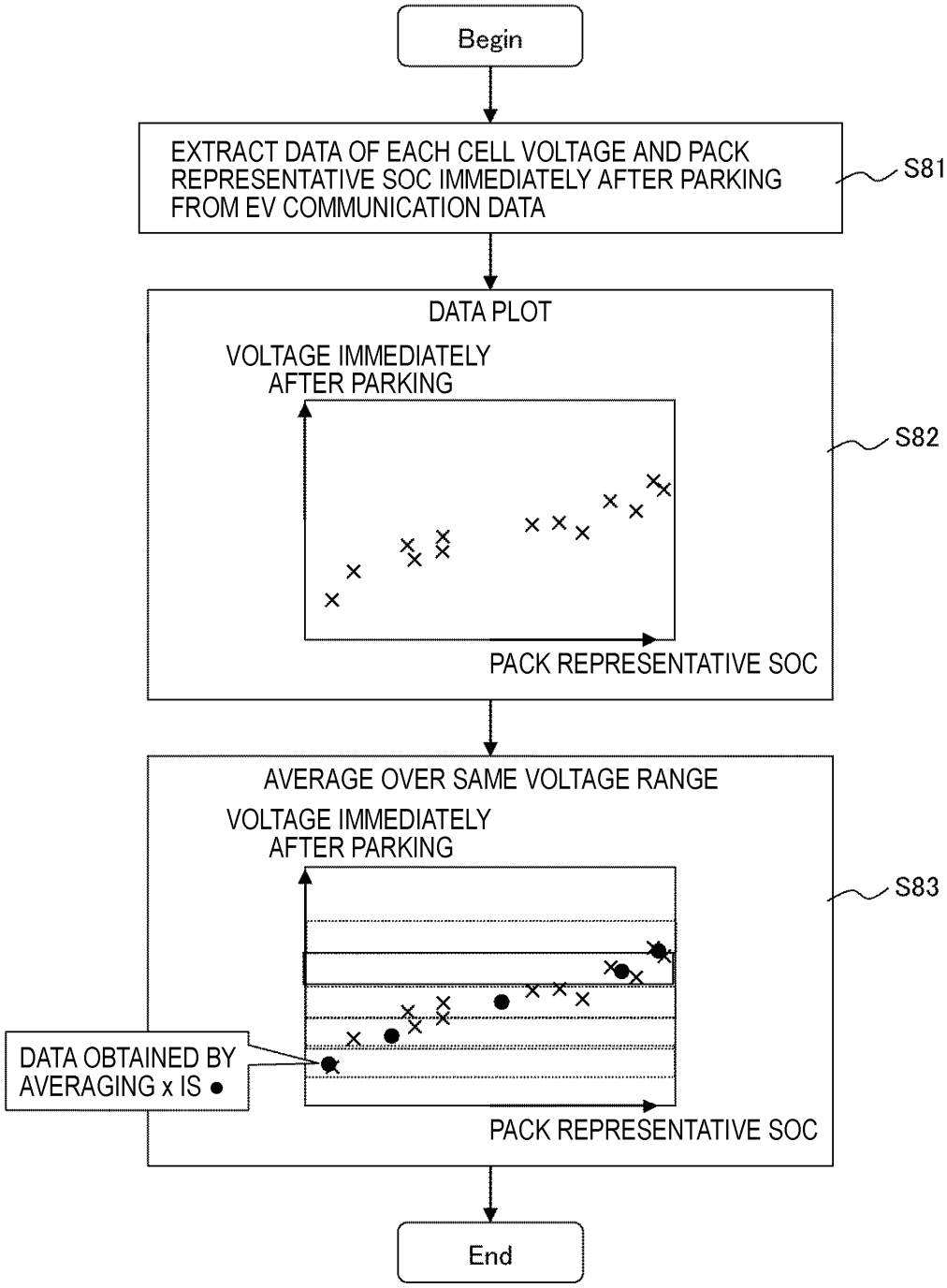
[FIG. 7A]


POTENTIAL[V]
SOC$_e$(1)
Q$_{max}$(1)
SOC$_u$(1)
Cell 1
Q$_{max}$(2)
Cell 2
CELL 1
SOC 0%
SOC$_e$(2)
CELL 2
SOC 0%
SOC$_u$(2)
Q$_{max}$(N)
SOC$_e$(N)
Cell N
CELL N
SOC 0%
SOC$_u$(N)
PACK
SOC 0%
PACK
SOC 100%
BATTERY PACK CHARGING
CHARGE [Ah]

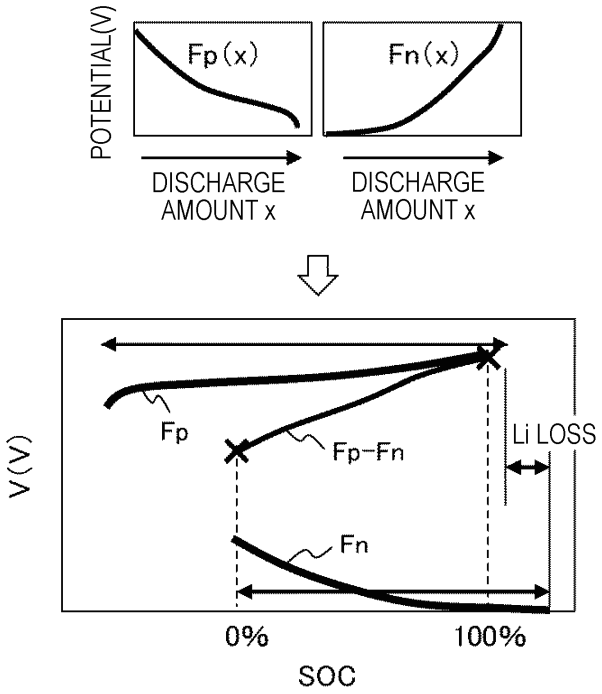
[FIG. 7B]


POTENTIAL[V]
SOC$_e$(1)
Q$_{max}$(1)
Cell 1
SOC$_u$(1) 100%
SOC$_e$(2)
Q$_{max}$(2)
Cell 2
CELL 1
SOC 0%
SOC$_u$(2) 100%
CELL 2
SOC 0%
Q$_{max}$(N)
Cell N
SOC$_u$(N) 100%
SOC$_e$(N)
CELL N
SOC 0%
PACK
SOC 0%
PACK
SOC 100%
BATTERY PACK CHARGING
CHARGE [Ah]

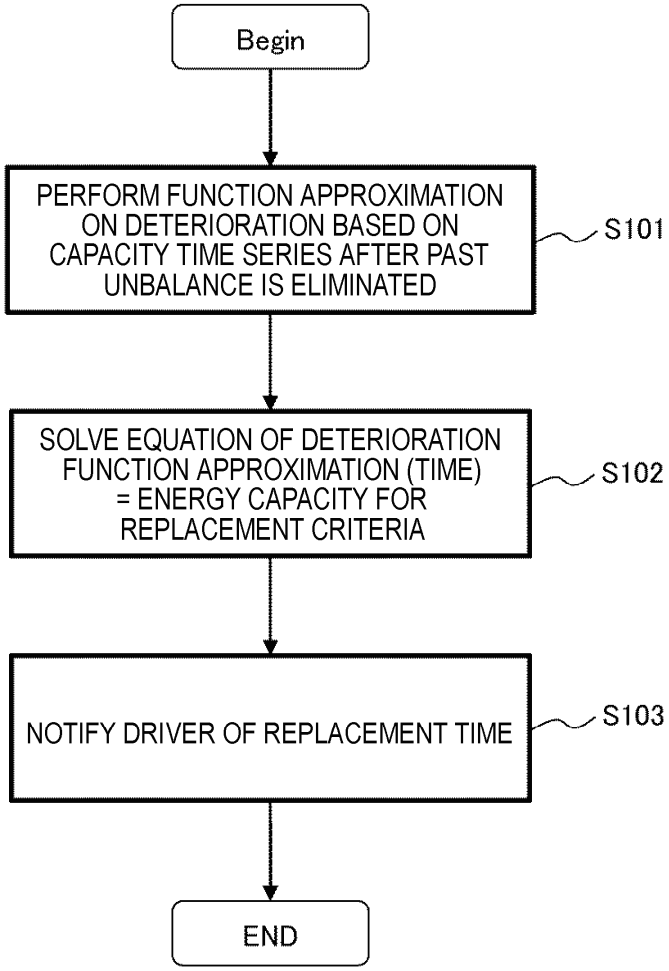
[FIG. 8]


Begin
EXTRACT DATA OF EACH CELL VOLTAGE AND PACK REPRESENTATIVE SOC IMMEDIATELY AFTER PARKING FROM EV COMMUNICATION DATA
S81
DATA PLOT
VOLTAGE IMMEDIATELY AFTER PARKING
PACK REPRESENTATIVE SOC
S82
AVERAGE OVER SAME VOLTAGE RANGE
VOLTAGE IMMEDIATELY AFTER PARKING
DATA OBTAINED BY AVERAGING x IS ●
PACK REPRESENTATIVE SOC
S83
End

[FIG. 9]


POTENTIAL(V)
Fp(x)
Fn(x)
DISCHARGE AMOUNT x
DISCHARGE AMOUNT x
V(V)
Fp
Fp-Fn
Li LOSS
Fn
0%
100%
SOC

[FIG. 10]


Begin
PERFORM FUNCTION APPROXIMATION ON DETERIORATION BASED ON CAPACITY TIME SERIES AFTER PAST UNBALANCE IS ELIMINATED
S101
SOLVE EQUATION OF DETERIORATION FUNCTION APPROXIMATION (TIME) = ENERGY CAPACITY FOR REPLACEMENT CRITERIA
S102
NOTIFY DRIVER OF REPLACEMENT TIME
S103
END

[FIG. 11]

No.	ITEM	VALUE
1	VEHICLE ID	VIN-123456
2	BATTERY ID	BIN-123456
3	BATTERY TYPE	LIB-123456
4	INITIAL CAPACITY (kWh)	100.0
5	CRUISING TRAVEL DISTANCE (km)	300
6	START DATE OF USE	2016/3/1
7	NOTIFICATION 1 : CAPACITY BEFORE UNBALANCE IS ELIMINATED (kWh)	78.0 OR LESS
8	NOTIFICATION 2 : CAPACITY AFTER UNBALANCE IS ELIMINATED (kWh)	80.0 OR LESS
9	NOTIFICATION 3 : UNBALANCED CAPACITY (kWh)	3.0 OR MORE
10	NOTIFICATION 4 : DIFFERENCE IN ASSESSED PRICE (YEN)	100,000 OR LESS

[FIG. 12]

No.	ITEM	VALUE
1	VEHICLE ID	VIN-123456
2	BATTERY ID	BIN-123456
3	FIRST CALCULATION TIME	2016/3/1 23:34:05
4	LAST CALCULATION TIME	2020/1/1 23:45:06
5	CAPACITY BEFORE UNBALANCE IS ELIMINATED (kWh)	77.8
6	CAPACITY AFTER UNBALANCE IS ELIMINATED (kWh)	80.8
7	MILEAGE (km)	234,567.8
8	NUMBER OF RAPID CHARGING TIMES	1234
9	NUMBER OF TIMES TEMPERATURE THRESHOLD IS EXCEEDED	543
10	ASSESSED PRICE FOR EV	808,000
11	STATIONARY ASSESSED PRICE	716,400
12	STATUS	NOTIFICATION 1, NOTIFICATION 4