**Non-terminals**

S: Start Symbol

B: Block of instructions

V: Declaration of Variables

P: Procedure declaration

PD: Procedure definition

Ins: Sequence of instruction

Cm: Command

CtS: Control Structure

PC: Procedure call

LV: List of variables

PD: Procedure definition

Prm: Parameters

Cdl: Conditional

RpTms: RepeatTimes

Lp: Loop

Cdn: Condition

NV: number or a variable’s name

**Special tokens**

<ID>: string of alphanumeric characters that begins with a letter; a name.

<NUM>: number.

<D>: left, right, or around.

<O>: north, south, east, or west.

<X>: Balloons or Chips.

**Production rules**

S → <ROBOT\_R> [V] [P] B <EOF>

V → <VARS> LV <;>

LV → <ID> (<,> <ID>)\*

P → <PROCS> (PD)+

PD → <ID> <[> <|> [Prm] <|> Ins <]>

Prm → <ID> (<,> <ID>)\*

Ins → (Cm | CtS | PC) (<;> Cm | <;> CtS | <;> <ID>)\*

Cm → assignTo | goto | move | turn | face | put | pick | moveToThe | moveInDir | jumpToThe | jumpInDir | nop

assignTo → <assignTo> <:> <NUM> <,> <ID>

goto → <goto> <:> NV <,> NV

move → <move> <:> NV

turn → <turn> <:> <D>

fase → <face> <:> <O>

put → <put> <:> NV <,> <X>

pick → <pick> <:> NV <,> <X>

moveToThe → <moveToThe> <:> NV <,> <D>

moveInDir → <moveInDir> <:> NV <,> <O>

jumpToThe → <jumpToThe> <:> NV <,> <D>

jumpInDir → <jumpInDir> <:> NV <,> <O>

nop → <nop> <:>

NV → <ID> | <NUM>

CtS → Cdl | Lp | RpTms

Cdl → <IF> <:> Cdn <THEN> <:> B <ELSE> <:> B

Cdn → facing | canPut | canPick | canMoveInDir | canJumpInDir | canMoveToThe | canJumpToThe | not

facing → <facing> <:> <O>

canPut → <canPut> <:> NV <,> <X>

canPick → <canPick> <:> NV <,> <X>

canMoveInDir → <canMoveInDir> <:> NV <,> <D>

canJumpInDir → <canJumpInDir> <:> NV <,> <D>

canMoveToThe → <canMoveToThe> <:> NV <,> <O>

canJumpToThe → <canJumpToThe> <:> NV <,> <O>

not → <not> <:> Cdn

Lp → <WHILE> <:> Cdn <DO> <:> B

RpTms → <REPEAT> <:> NV B

PC → <ID> <:> [ NV (<,> NV)\* ]

B → <[> [Ins] <]>

Note:

1. Every variable must be declared.
2. A block of instructions can be empty.
3. A declaration of variables must have at least one name.
4. A procedure declaration must have one or more procedure definitions.
5. Only the declaration of variables or only the procedure declaration is allowed.
6. “assign\_to” command’s <ID> can only reference a variable’s name