University of Technology, Jamaica

Faculty of Engineering and Computing

School of Computing and Information Technology

Theory of computation (CIT3006)

Semester 2 – 2020/2021

Utech TOC Ultra vehicle control system

Group Members

Kyle White - 1807920

Samuel Matheson - 1708148

Mattania Mckoy - 1704278

Lecturer: David W. White

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a := start signal   variable *s* := **speed**

b := brake-held signal

c := seat-belt-engaged signal

d := drive-selected signal

e := park-selected signal

f := accelerate signal

g :=reverse-selected signal

h : =brake-pressed signal

i :=set-cruise-control signal

Description of DFA

The Ultra vehicle control system (**M**) consists of 8 states {Off, Ignition-On, Engine-Started, Hold, Stationary-position, In-forward-motion, In-reverse-motion and Cruise-control-engaged}.Throughout this document these states will be represented as {Off, Ign, Eng, Hol, Sta, For, Rev, Cru} respectively. **M** only accepts input strings that end in the states (Off or Cru) and reject otherwise.

$L_1 = \{ (aa)^m \mid m \geq 0 \}$

$L_2 = \{ a^m (ba \ (cf^n (g \ (f \cup h)^y \ bf^i)^j \ e)^k \ a)^t \mid m, n, y, i, j, k \geq 0, t \geq 1 \}$

$L_3 = \{ a^m ba \ cf^n (g \ (f \cup h)^y \ bf^i)^j \ d(f \cup h)^q \ (if^e h (f \cup h)^r)^s \ if^o \mid m, n, y, i, j, q, e, r, s, o \geq 0 \}$

$L_m = \{ L_1 \cup L_2 \cup L_3 \}$

Language of M = Any number of 2 **a's OR** any number of **a** followed by a list that must have 1 or more copies of itself containing a single **b** followed by a single **a** followed by an inner list (1) that can have 0 or more copies of itself containing a single **c** followed by 0 or more copies of **f** followed by an inner list (2) that can

have 0 or more copies of of itself containing a single **g** followed by 0 or more copies of **f or h** followed by a single **b** followed by 0 or more copies of **f,** end of inner list (2). This is followed by a single **e,** end of inner list (1). This is followed by a single **a,** end of list **OR** any number of **a** followed by a single **b** followed by a single **a** followed by a single **c** followed by 0 or more copies of **f** followed by a list that can have 0 or more copies of of itself containing a single **g** followed by 0 or more copies of **f or h** followed by a single **b** followed by 0 or more copies of **f,** end of list. Followed by a single **d** followed by 0 or more copies of **f or h** followed by a list that can have 0 or more copies of itself containing a single **i** followed by 0 or more copies of **f** followed by a single **h** followed by 0 or more copies of **f or h,** end of list. This is followed by a single **i** followed by 0 or more copies of **f.**
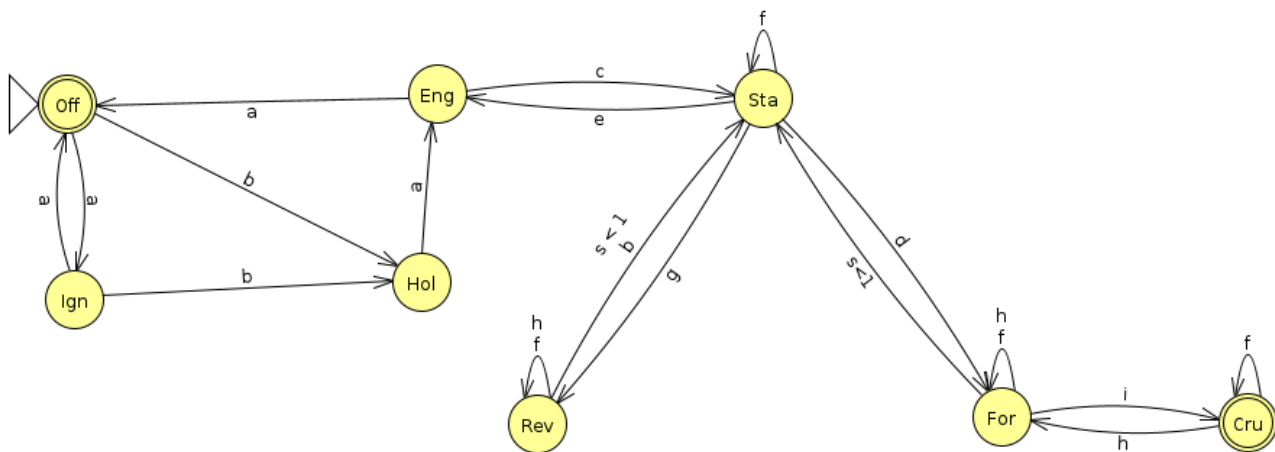
Figure: Showing the DFA state diagram for Utech Ultra vehicle control system (M)

Formal definition of DFA

Utech Ultra vehicle control system (UTuvcs) $M = (Q,\ \Sigma,\ \delta,\ q_0\ ,F)$ where

$Q = \{\ Off,\ Ign\ ,\ Eng,\ Hol,\ Sta,\ Rev,\ For,\ Cru\}$

$\Sigma = \{a,\ b,\ c,\ d,\ e,\ f,\ g,\ h,\ i\}$

$q_0 = Off$

$F = \{Off,\ Cru\}$

$\delta =$

Q	a	b	c	d	e	f	g	h	i
Off	Ign	Hol							
Ign	Off	Hol							
Eng	Off		Sta						
Hol	Eng								
Sta				For	Eng	Sta	Rev		
Rev		Sta				Rev		Rev	
For						For		For	Cru
Cru						Cru		For	

Table: Representing transition function of states in M

Formal description of Language for M

The Regular Expression of the language

$(aa)^* \cup a^* (ba\ (cf^*\ (g\ (f\cup h)^*\ bf^*)^*\ e)^*\ a)^+\ \cup a^*\ ba\ cf^*\ (g\ (f\cup h)^*\ bf^*\ d\ (f\cup h)^*\ (i\ f^*\ h\ (f\cup h)^*)^*$

if^* and is rejected by **M** otherwise.

Extended transition function

String w= *abacgbdi*

$\delta^*(\text{Off},\varepsilon) = \text{Off}$

$\delta^*(\text{Off, a}) = \delta(\delta^*(\text{Off},\varepsilon),\ a) = \delta(\{\text{Off, a}) = \text{Ign}$

$\delta^*(\text{Off, ab}) = \delta(\delta^*(\text{Off, a}),\ b) = \delta(\text{Off, ab}) = \text{Hold}$

$\delta^*(\text{Off, aba}) = \delta(\delta^*(\text{Off, ab}),\ a) = \delta(\text{Hold, a}) = \text{Eng}$

$\delta^*(\text{Off, abac}) = \delta(\delta^*(\text{Off, aba}),\ c) = \delta(\text{Eng,c}) = \text{Sta}$

$\delta^*(\text{Off, abacg}) = \delta(\delta^*(\text{Off, abac}),\ g) = \delta(\text{Sta,g}) = \text{Rev}$

$\delta^*(\text{Off, abacgb}) = \delta(\delta^*(\text{Off, abacg}),\ b) = \delta(\text{Rev,b}) = \text{Sta}$

$\delta^*(\text{Off, abacgbd}) = \delta(\delta^*(\text{Off, abacgb}),d) = \delta(\text{Sta,d}) = \text{For}$

$\delta^*(\text{Off, abacgbdi}) = \delta(\delta^*(\text{Off, abacgbd}),i) = \delta(\text{For,i}) = \text{Cru}$

The string *w* is accepted because it ended on Cru, Cru$\in$ F.