

!''#\$\$%&'!(*)'+,-+. .)&*!/'-%- /!(1!&1'!(0&+-)2+,,0!21,,%2'!)&(11!\$!&+3)*+')1&!(+'+(#%!
'1! 4%)\$!\$%)+&2%!1&!/+'%,,'%5(% . %&(%&'!%24&1,1*)%/6!''1&/%7#%&',08!(*)'+,-+. /!'%&(!'1!1&,0!
199%\$!1#'(11!\$!&+3)*+')1&!/%%3)2%/6!: 4%! . #\$. 1/%19!- 0!. \$1;%2'!<+/'!1!%/'+=,)/4!+!&%<!'%24&)7#%!
91\$!+#'1-+'*)&! 4%!21&/'\$#2')1&19!)&(11!\$!- +. /6!>0!/'-%- +'')2+,,0!+22%/)/&*!/%&/1\$!9\$1- !
- 1=),%!(%3)2%/!'1!2\$%+%8!21,,%2'8!+&(!. +\$/%!/%'\$!&+3)*+')1&!(+'+8!?'+'- . '%(!'1!- +@%)&(11\$!
(*)'+,-+. .)&*!/'+'%,,'%59\$%8!+#'1-+'')28!(0&+-)28!+&(121&'\$1,,%(6!: 4)!/1,#')1&!- +0!=%&%9)!
/%\$3)2%/!\$%7#)\$&*!. \$)1\$!@&1<,%(*%19!.\$)3+ '%!#=\$+&/'\$#2'#%\$/!/#24!+!9)\$%9)*4*)&*!+&(!,+<!
%&91\$2%- %&'8!+&(!.\$13)(%&+3)*+')1&!/#. . 1\$!91\$!3)/#+,0!- . +)\$%(!&()3)(#+,/6!

: 1!+24)%3%'4)!*'1+,8!?!- . ,%- %&'!(!/'-%- !'4+!(%'2'/'!+&(\$%*)/'%\$/!/- +,,!/2+,%!
&+3)*+')1&!<)'4!#'\$!\$%)+&2%!1&!A,1=+,!B1/)'1)&*!CO'-%- !DABCE6!?'/%+(8!- 0!/'-%- !,\$%)/!1&'4%!
user device's accelerometer, gyroscope, and magnetometer to dynamically construct virtual
'\$+;%2'1\$)%/6!F)' +&2%!/!+&(!()\$%2')1&!/!+%!/%'!9\$1- !'4!%=4+3)1\$!19!'4%!/%&/1\$!8!+&(9!1!%+24!
21,,%2')1&!/%%/1&8! 4%/%!&+3)*+')1&!(+'+21,,+. /%!)&'1+!. +'4G!%1- %\$)2+,,08!+9,1+')&*!)&%!1&!+!
- %'\$)25=+/%(12+%'!)+&!*\$(6!B+'4!21&/'\$#2')1&!/11&,0!+2')3+%(1<4%&8!#)/&*!A11* %!/%\$3)2%/8!'4%!
/0/'-%- !(%%2'/'!+24+&*%)&!#/\$!\$,12+'')1&19\$1- !1#'(11\$!'1!)&(11!6!: 4)!%&/#%\$/!4+'!%+24!2\$%+%'(!
. +'4)!/'+'%,,'%59\$%8!+&(12+&!=%!/'!)^&*(!'1!)'/'+'%,,'%5(% . %&(%&'!41/'!=#),()&*6!

: 1!\$%)&91\$2%'4!%3+)(O!19!'4%9)&+!(+'+8!'4%!'0/'-%- !#%/!2\$1< (/1#)\$2&*!1!) - . \$13%)!/'!
+22#\$+206!: 4%\$91\$%8!%+24!=#),()&*!/'!21&2%!'!'1+!. 11,!19!. + 4!)&2\$%- %&'+,0!9),%(9\$1- !
(99%\$%&'!#/%\$!6!B+'4!21,,%2')1&!/!)'4%\$!2\$%+%'!&%<1!\$!21- . ,%- %&'\$+0!)&%/6!: 4%! . +'4)!/'!%&'!1!
)'!+//12)+%'(!. 11,!D<4)24!)/!)&@('!'1'4%!/ . %2)9)2=#),()&*!3)+!(*)'+,-+. .)&*8!%6*6!- +. .)&*19\$1- !
A11*,%!H+ . /! B?/E8!+&(9!9!+!/-),+\$. + '4)!/'!+,%+ (0!/'3%!)&'4%! . 11,8!'4%! . \$1=+=,))'0!'4+'!4%!
=#),()&*!21&'!+&/'!+4+,,!1\$!+!21\$\$)(1\$!+/'!4+'! . +'4)!/!)&2\$%+/%(6!J'4%\$<)/%8!'4%!&%<!. +'4)!/!+((%(!
'1'4%! . 11,!<)'4!+!,1<!. \$1=+=,))'0!19!%K)/'%&2%!)&'!4!%=#),()&*6

''1#(!/'1\$+*%!/%%3)2%/!+&(!+#'1-+'%(!. %\$-)/!)1&!- +&+*%- %&'!+\$%!#/%(9!1!/%2#)\$&*!
#/%\$!(+'+6!L)'4!+&!+0&24\$1&1#/#. ,1+(!/%\$3)2%!21&/' +&'0!<+')&*!'1!-)*\$+%'!&%<,0!21,,%2'(!
. +'4!/1&'1!+!2,1#(5=+/%(! (+'+=+/%8!+&(!+&!)&(11!\$!- +. !()/'\$=#')1&!) -)%(!'1!\$%+()&*!1< &%(!
21&'\$#2')1&8!'4%!'0/'-%- !(%,%*+'%!/!%2#)\$'0!'1!4)\$ (5. +\$'0!*\$1# . /!<4),%!!%&/#)\$&*!'4+'!%&(. 1)&'!
(%3)2%/!+&%!#&+=,%!1!+22%/!\$%/'\$)2'!(+'+!1\$!21- . \$1-)/%!+22%//%(!&91\$- +)1&6!

!'4!#*4!'4%!'0/'-%- !)!2#\$\$%&'0!#&+=,%!'1!*\$1# . !. +'4!/<)'4)! . 11,/!+&(!,)&@!/'% ,9!'1!
2,1#(5=+/%(!. +'91\$- /!91\$!)&2\$%+/%(1/%2#)\$'08!+,,!1'4%\$!/%''*)&/'!+\$%!4+\$- 1&M%(!+&(!.\$1;%2'!
'1,%\$+=,%!. %\$91\$- +&2%!# . 1&!9#,,0!%7#). .)&*!'4%!'0/'-%- 6!|!- +;1\$!//#%)/!'4%!&%(!'1!41,('4%!
- 1=),%!(%3)2%!3%\$)2+,,0!D. 1\$'\$+)'E8!(#%!'1'4%!'%24&)2+!,+//#- . ')1&'4+'!4%!(%3)2%!4%+()&*!(1%/!
&'!(%3)+%'!9\$1- !'4%#/%\$!4%+()&*6!: 4)!/!/#%!. %3%&'!)&()3)(#+,/9\$1- !#)/&*!'4%!'0/'-%- !4+&(5
9%\$%6!|1/1,#')1&!<1#,(!\$%7#)\$%!'4%!#/%!19!- +24)&!%,+\$&)&*!'1!+#'1-+'')2+,,0!4+\$- 1&M%!'4%!#/%\$!
4%+()&*!<)'4!'4%!(%3)2%!4%+()&*6

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