

	Grasp Recording [GraspIt!]		Motion Planning [OpenRAVE]		Motion Execution [R T oxysten	
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/2-&3b9SYfW6Ad]BenNodm02YH]ndS]^\Wm/C\VbSd\OPPmH m Cm[°] HGHNLoell CE EFAW CHbmS[°] bmmHd[°] SHJg [HYGdmO, KB 60 dCE CCFb FH] mG Sal Y, Phm dQHHm_fHbdHGm YC**d\SbY@Cnd**YSYfj]\dnS]S\bmWVC\\fbl\SS\mdPOmHm /^H\4. bmSYfWACd]BB]AnnH\H′0Cubd]HSobh′dCmUHBjd/obmQyMHCm\S^fWCdS]\m d C b //\ Fm+C ndn] S & tdCmU H FSdbP]mHj \mH ' CSddSHbbGnHinkdd] dnmQ 'Hj nEn] di Rh '] f P On m 'HCW EIJS\YdHbijnjWoloonHell YOmFF]Y^WYOLYBIOCh\mS^fWdCdbSVj\mm

m 2

JUY?KdSZZUJd?Jda > X; SZU6YK > ? XKK1SZd?SZ1XX1X10J22x1d?d MKS?Q;ZOKU=>d?NJ@#ZdJ?XdU<U;ZSd+KJZY?dSYUXZY?ddNQ;SUK>d X U < UOZ; da d\ Z K N K db>??d> K = ; Z@? U> Xd = ?UdS Z X U ⊠ NI=8/UX Q/V ? S Y ; Z ? d @UX\$d? 'V ? = Z ? b} & Z ; @ZUdX ÷ \$ al Z UVdX ? > K_=JZ?dZ J ?ZXJd?JdU Y ? d K YVdX U V ? XUNXaKd? S Z; S > dlN K I S ?_>KdZ JZ dl ?Jda > X ; S Z d "SoZJK V/dV?XUoLX@eU = \KYYdddSoYN;SSK\$XKoQoZX;L? = ZUXK?Yd @ U X Na NZ dJ ? CL U Z K U SZ YUddX ; Y VZdJ ? dl U Y ? Z dX ; S Y V UKXZZdHJZJ ? d @ U X Na NZ dJ ? CL U Z K U SZ YUddX ; Y VZdJ ? dl U Y ? Z dX ; S Y V UKXZZdHJZJ ? d Ja > X; SZS d/dK SY? XZZ @l.d/U Y?KdSZ 12/d/?.d/a > X; SZ5 JdK N?_d?d J; ^ ? S KZOdVN ? Q ? S ZN2 B& ddl?>d? > K = ; Z=?U⊳SdZ X U N; N 80 X 17 el K E ? > d

B. Our Appr ach

:S>@S^KXUSQ?\$S\$Z≑N?&Z:KSZK?Y d

; < U ^ ?_ @idJ; ^ ? 1d U X Z ?Z>Jo?VdN; S S ?O>UdZ K UZSUb2dJ?VdJaYK = ; N d OJ?JUUY?KdSYZ;NNQ??YSMZ104W\KXZ??KdSZ?IX;ZUK@U6Kd@@?XXcU<U?350F01'?=\Z?Z>J0?O2UUZKU\$YYMdI\XKdSKZKC?NYdLNZ d 2 S 7VdN · S S K · SS statel II S 7 X · IN NI /d X K 7 I / 5) 7/ds d? = 11 O V / 17/ 12/37ds Y M d """ Od d 2 * d5 / / 8 m

KS777U.d?@dUNNU &K9NXKd< 7:Y:N3Xd??? = XKU<\?XdX/VXU:= Jd A. Hardware Overview Z U?d; = J ldl @ZdJ ? Q d

2 * d K Y d@ &INN Y K 1o Q > SdU K X k0l < U; K3 d k0l V ? S V N; Z @ U X Q d OJ?EXYYZ\d< Z; @PM/Z£Ud?Jd\Q; SUK > dXK2¥Z600≫2d?dZ? <u>≡</u> Z?dX?d ZJ?dUY?KGY;GS> oZUMIN;S;od= UNNKYKUSQU®ZXK?UZZ3da/btX;YVd >?^?NUV;?Z>d4d "/Od KI\X?Od; "ZbktYd = QoZ;NNSd>d KZ"53/dUXMZ/d?FdX?LdUY?KdY;dYY\Q?72/dud?&XKIK55?dd __?KIJY;eIU\ZdMI"65/a7?XQ1/bf@f0d?=J;SK=Y2/d*d_J;Yd_d ;X?VaIN;SSKSZUWaU\Z@UUX=? ZUW??VaSW?UdaU336aTJ?XaU<UJZ60>d >?IX??Vaf@e1X??>UKQSd=N\>K50Wd564?;=J6N?I ddUS67;=Jd YUZUJ; Z=dUSZ; @ZUdX = 2; YSatel? 60; ?; Y \ X ? <> and Z J ? G Z dK Z JZdUKY dt X Q ddUS 61; = Jal; S > ddUS 62 J? ZdUXY US ad dUS 62 J? Sd? = M d Y ? S Y U ¥ a Vd; < K N Ko2@aU Xd = 3UdQ V ? S Y ; 27 VX XU dI X ; Q dS d ? Vd Y ? > d ; = J dL U K SC 27 add K K ^ ? Sa dd d< X \ Y J N ? Y dY Qd U Z U X Kd Z J d X Q U S K = d Z U=dU S Z XZW NidX; Y V K SQIUdZ K U"SS;db > K Z K ZU S?idd; Y V K SQIUdX = ? el X K ^ S el dl; Y dS dU V Z K =?;SN=dU > Z XI dZ NI N U _\Wc2 XZ/dd=dU S Z X U N d = U S Z X U N Xik? Niki20.p??Zcdi = Z KYN??SchY U Xi 37 Zi J ??dU < WZ 3i > Y; 3i > d ?; = J bl U K S 3i bl ??KdS > K ^ K > \ ONUN? xi ?; dM ? 4? U \ X cl; 'K Y@dU X = ? c = U S Z X 12 1N 28 407 Z = U U X + U 2 = U S Z X 12 1N 28 407 Z = U X + YNKVVK,\$\$\$\$ ¢dlYY\XY?Zd; < N≢?UdSZ; <u>=</u>KZdZJZdJ?JdUY? d US?KdS?XZ0Q?NVd\X?Q?%S5ZKd;ZZddZJ?=d?SZ?UX@bdd?N^K*SY6K>?d

@Z?ZXJd?JdUY?KdYdK;YV?ZJd?Jd\Q;SUKXsud<UVZKdA\[Wad]?dZJ?XdU<UZ_dU=dUQV\Z?XXY?dxUU=;ZX/sadJ?+dJ?YZ*Sd?J<dXYd JUY?YdUZdJ; ZZd/?X;USN; Mat?SYUQ?=dN?;X;S<??Zd_??Zd_??Zd_??Zd_??Zd_??Zd_??Zd/?KSN;Mat?SYUDX?dY\X?Q?SZd?Ud((d) ; S > 07 J ? 74; < N 27 Udied; = K N K 02 UZZ?KUUVSNU; S S K Se UUXZ AL; S Y V U X Z K-SN Y0 uS > 07 J ? 101 Z J ? 101 Z J ? 101 63 ? <u>d</u> U X M Se du XU0Z J ? 104 dU = ? Y YY? Y=d); 0Y d ZJ?JdUY? "SI&TJK VXU = ?YZYJ?XdU < UOZ;da:dS?? >ZdU;d>L \YKZZHYdV?X = ?VZK\$U>SddK IJ N?^=?UNSdZ X LODN?dX?;N Z KLO2Y?dX;ZKSId < U > aVdUY ?VdX U V ? X NKa7dLtdl= ? S 7 ?UX@?Dd: Y YbdUY K 7 K U 18 td d Y a Y Z ? O-d0 6 dS > el \YZ U O. K b=?U-SdZ X ŁUN:dX >: Xd? ZU ? Qd : K S d = U S Z X U 🛽 NN/17 X 2017 dt?bod? X U Q U Q X SUZKOS 28 dt, dU @Zoll?XdU < U Z o@?;Z \ XU?@Zoll? 2 Q 2 * d X U < U_ZJoK = J=dU Q V ? S Y ;@Z 10 28 ut?>d? N ;a d _KZJKZSJoPYd\VVUXKDIoNAIUS d : S > dK S Z ? X V U ⊠ JZ? 2H&IX UYXUd Z J : Z:dd \ Y ? X=d: S d≢ U S Z X 12 : N≡dJ d

OJ? dZ JKX ½ Ya < Z; YKWY for Uel; XX a2 di? dr UY? ZU for J? for V U Y K Z KOULS & d K Y 6I > ZdJ ?. Ll \ Q ; S U K X tl < UEZXHY Z & Z ? Z Y ?d O J ? X ? Xl ?Z _ UXU < UIZ 6I > YLUS & J ? d 2 * d X U < U Z Sd ; = J d Z;XI?;ZSd>bl<YZ;=N0?.Y?\$blklZ;07.5;X;Z?d*edUNNKYKU\$V;20.4%Zd/?07.04/2019;20.2.**dJ;S>Y;Ydb1/JU_SKdS;0KI\X70d<ZJd?X;?Xd?Ed^?d ZJ;Z:d?ES?YZd?d;NMKSM;dZJdS>dZJ?@/UUVZN;=?Q?\$XZ5ddESI?X¥dUSS?=ZZ2->XdU\l=/d<N?Y;=dJdU@ZdJ?Y1263I?XW;d/d X?:NZdKQ? WISYK>?XKZSI?#ebelJ;SI?#ZU#ZJ?NJU=;ZKWU@S7ZHJ?d > XK^?sardedYQ;NNddQUZUX0J0?63?7J0X;YVKS@IWJX+X?/ddd(d UXKIKS;UN/dd U@ZdJ?XdU < U=Z;dx Y? × da dZJ?Xd'ZX;_d?KIJZJd@ d 5?dx Y?ZdJ?*dV?S-4 dYU@Z_;;XY?ddY?dKQ\N;ZKDSKdXUSC Z J ?JdJ Y ?Z d/?_d; N M K \$; Hd ZQd; a ck ? rd> L \ Y Z ? >Yd? ±Jd\$ZdJ ?Sd? _ d Q ? S ZZdU YdK Q \ N ; Z P ?dd2 * d X U < U; Z 6+ & N; SXdJ < UOZ wI Z K U S Y d U'd VUYKZK"USS2Z1d?Q1?;SZKQ.2,JO?83/,d = USZXUNXMN???XV0/d9 : 0dJKYYdKQ\N;ZVUXXud^KZJ;ddZUUX2/ddXkZJKS2. = USZXUNZUK?Sdlubl< UZZubleIUNNZJ?3cbal?YKX285,ddZX;L?=ZUX/aXdUZUZaSV?260/;N\;Z-?KdC?X?;SNZ1dUXKZJ;CS1×ddS;NabZ2/d?d > ? E S ? ∞ al 27 J ?_d; N M K \$V ¦, 27 J; 05 > dP U UVZNd; = ? Q ? S 27 V3 V ; X ; Z ? 02 U Z K U/S@21d) ? 02 * d X U < U*ZS ?d 02 ; X S@2 ; Z \ M @*dM ? S - 4 d N : S > K S= IUd S Z X U N= NU 70XVd? S Y ; Z@?VY X8 d ? d S ? ' V ?= Z ?= Ud S Z := Z Kd Y Z1 J ? U V ? S Y K Q \ N ; 20 KU U-S, dN Z d1; Z Kd Y KM K S ? Q ; Z K = ; 35 I+N da d > a S; Q K = ; NYNaaSd= J X U S K <u>b</u> R Z dddJ? d 2 * d X U < U Z_ JdK = J d @UX = ? Y\dY ? × d d J ? I d X U \ S > d J S Z : = Z d

* S = ?ZdJ?JdU? ?Kd/ZdX; S Y V U XZZJZdzł?dda > X; SZZJ?ddc Q; S U K > d; N N U _\YYd? XZ/ud;d/ V N ažd? K; Xkud U X K Z JZCU%dd?VdJ a Y K = X N el U Z d X U < UO2 1dl ^ ? YZ dl ? dl U Y ?Zdu Zd J ? dl a > X ; S Z ?d @ U XK ?Z Kdd S Y ? XZZ JY? dd ; S > d? ^ ; N \ ; ZZ? Jd? Xd ? Y \ N 12 \S dZ J ? d 2 * d X U < U Z K dl \ X ? dd

; S > CHUN \ QW2/dL; N K Z K_? WK?d= U XZ >J 61_dX K WZUdY ?Ud@ZdJ?XdU < U Z d J; S > d S > dZ J? Ld U K S; ZS dl N ? YU d@ Zd J? El S I ? X YO Ld ? Y ?Sd\ Q < ? X Y d =; S & U; Z ?~X?d & Y ? >ZdU Yd V ? = K 22 Ja?dd; S > & U Y Z \ X 12 IddX; Y VZdJ ? d = U X X ? Y V U S Ы K 1S. P.d= ZY odd S dP. '; Q V N ? Kd I \ X ? d; Xd J U _ Y; dd YZ; < NX; dYVUd@; dd 2 * d J; S > bd S; ddVKV?_dK = JKdYUd < Z; KS? > d $Z J X U \setminus |ZJ dK W X U = ? Y Y d$

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C. Motion Planning

"SZUJ?VCX?^KUYZY?dZ_?CdL;^?Xd?=UX>Y?Z>;dtNX?;dYVUYBizdK@c ndm ydduubo-hq-dandumo-od-oyd-udbu+sy-zdysh-danynduubo-h~maub~ @?X?USZU!?=ZSYdGdU_SI??zdUVdN;SLdUKSZdL?=ZUZVU&d0740°d dq nu-du+boonelojbu-qyms-Triqsjo- du_bqs--hyoudisn-+u-b min © byumaye-urb-tou nu-boece ma-boeco, ntn f etn(ytuur/jj-b ZJ; dKQ dZ UZdJ? ldX; YVK SVI LdIY?? 'd? = ZZ. d? VdX? > ? ES P.X+; d'V db n w mBs \sim

: S > d= = U O V N K Y 3Xd? YU7 @7dl ? Od: S K V \ N : 7 K U/SVd? & ? X : 7 K S I d LUK SZXIdL? = ZU=X; KS?d1?; d= JK? ^ ?< a bd/YKS; ISdd? 'KYZO2 US7ZKUUS d VN;SS?'XSkoldAX_dUXM_?dd?'VNU2KJZ??0dUZKUVSNd;SS?VXKdUVUY?>d D. Motion Execution < a d ? X ? S Y U?SZddN [1d9]. O J K YOdU Z K UVSNd; S S ?KXYdd; Y ? >UdS d

USYZX; KS?K>dKX? = ZKU; \$V; KN>dN a ? ' V NU X \$K \$SU 60 (01 X ?? d) OJ? & ? Y \ N ZK \$S; 1 (d? = ZU) & ZdUd? d K - - O dV N; SS? XV (d? = K E? Y d) K - - O _ dS > VdN;SV/K9.=dUSYZX;OK;SS2Kd@UNK/SY-X0t=?<abd UY?d^ZJ?LdUKSS26tdN?Y2da4KC?X?VSUZKdS2UY@2do4KQ?__btK = JKdYd;NYUd;d = U S Y Z X ; K;SYZL_Y?dN N Ya'dU Z J ? X=dU S Y Z X ; K OS Z ??Y ?elei U S Y Z X ; K S 코 Ų Q¹ N K Y K U SI X @ LX?? ⇒ Zdob Ma SI odi ?Yd U < U;ZK oD oZ U OD U ^ ?Zd J ??dS > d ;X?'dY?X >?E\$\$\$>dX?'d?X&a'd?@`%eNUdbleiL? €Z5iKV\N;ZKU?SCd? = Z1Z1X07adU?Zd;XI?IZXd;YVKSVIUdY?5161Z3;6164'ZXX62 ZKQKSId Z;YMYU0XXX;QVN?_01d=;S0LY?20J?Y2;dUSYZX;KZSUZ04MNd;Sd^VXU=?¥Z10020J?d?S?X;Z?L>UdKSZZXd;L?=ZU_X?ad;S0;Nab 22d?d _ J K N 174 d? ? V K KS 125 dbl X K b U S;12N;0N Sal12 dl ?Vd;Z J 5 d? d= ; S xdN Y 10. bd ? d U @?d = J ld U K S 127 30 d K Z J KKSZdM & Q K 25 a3 du K 14721? V_ 3 dd V V N a3 d K Y d ZJ?Y=? bd SYZX; KZ 55Y27W?d= Kl@XaYd V K Soe doe UX>; So=U?>XKbdC?X?SZd/K SZXdL?=ZZJUXZdal 6toXQ el USZXU K2 bN/26tX el \ZZ?Jd?ZdX;L?=ZUX a d $\mathsf{U} < \mathsf{L}~? = \mathsf{Z}~\mathsf{VI}~\mathsf{X}~\mathsf{idd}'~;~\mathsf{Q}~\mathsf{V}~\mathsf{N}~?\mathsf{Y}~\mathsf{Kd}~\mathsf{S}~=;~\mathsf{2l}{=}\mathsf{d}~\mathsf{a}~\mathsf{N}~\mathsf{K}~\mathsf{S}~>~\mathsf{XVKK}{=}\mathsf{V};~\mathsf{iN}~\mathsf{dd}\mathsf{X}~\mathsf{d}\mathsf{U}~\mathsf{Z}~;~\mathsf{Z}~\mathsf{K}~\mathsf{U}~\mathsf{S}~;~\mathsf{N}~\mathsf{VN}~\mathsf{S}_{\mathsf{a}}^{\mathsf{c}}\mathsf{d}\mathsf{d}\mathsf{X}~\mathsf{U}~<~\mathsf{U}~\mathsf{Z}~\mathsf{d}$

Y 7 P R T ? Z ;XXKU=\dS K @I ¥ @I S Z ?;XS addi X ; Y V X bul Z ; Z ? X-bul \ S Z bl ; Z d "S bul \ X_dU X MZ bl?XdU < UKZ\dedU S S ? = ZZ?U-zobul - O 6 dX ? ; N Z K Q ? d ; 'KY_dU\N × & 2012 W\K^; N; 75 S> 22 dd ? a'r dd ; NSNLd Z< d? xel K C ? X ? S Z K ; Z ¥ § Y & ? Q JdK = J\dV > ; Z ? 24 Jd? Qd U Z U ¥ bd Q Q ; S > ½ Zd d d E ' ? > de X ? c "SZIJKY0K--OdVN;SS?_X?del;SYdV?=KZ©JaKdYfadQQ?ZX,Ya/ddd W\?S=QaJZdVVV?X/bJ>adXQY,SI>5J?=N2/bd/KSZKW=db/JSZXUNN?>d IX;YVK\$,@d@UX>;\$\$=≈;ddNNUU∐20J??XW/\K^;NI?X\$,27b/37b/a/d;Zd bd;S>o2'J?NdU_?X:du>adN?IY80>o2'UXYLUb4KSZKYYdd UV?X:Z?Z>dd b QdJ\Y:dd?S?X:ZZXdL?=Z@UXX26.dd?XdU<UZd = USYK > ?X? > d

OUxol? VX? YYSUZYO≙dUS YZX; K,SSzZoMCdUX >; S = 70Y, YoM//o¥/; = ?d ; XQ elUS Z; KZSJY?dd; N\?UYoe?d = JLdUK SYZo?o? Xad bd? = US QUod -? IKUSY0d / - _d? X?KdSZXU > \ < 2i el?dX?SYU?SZ0dN d ZKJS?dKXd Y ; Q V N;??dd ⊨dJ Q Q ; S ∠ dd?d; = JQJ U Z U ¥ dd S Z X U N N U _ K_S bl Kd^?; d< X K ?K @S qZ X U c * S = ? ?d ; = J ?d U Z U ¥ bl S Z X U NXN? ?≥ x? dd ^ Z?J??bd U K S ZS dd N N N ??d; N \? d * S = ? ?d ;= J ?d U Z U ¥ bl S Z X U NXN? ?≥ x? dd ^ Z?J??bd U K S ZS dd N ??d; N \? d KZl67S?X;Z?57dfdV\NY?ZYUddXK^Z?Jd?ddQUZUXOJd?d"d _UXMKdS[d19] @UXQdUX?xd?Z;KN,SYxdd?'VN;S;ZKUSdYOd/-d = U S Y K 10 Zezűdda X ? 12°; dX Z Y didZ X ; S Y @ U X Q @ D X U Q al ? Ud X K I KUSædd V U Y K Z K⊨ W SS of X U NI SU?3?; ⊁ diQiU Z U ∔ kdiS Z X U Ni Ni SIX Xa 12 IN ?K dbl K S Z d ZJ?_dUXNZ-bb/ZdJ?0d/-dG;Q?dI ddZX;SY@UXQ@DXUQ#d?d; SIN?_dKZJZdJ?0d/ZK=?;SN=dU>?Xd

O / - dG; Q? dI Z UZdJ??dS >?d@ @? = *Z USC dI d d6 2 Q; Z X kB d $4 \quad d > 2 \quad 4 \& , \quad .8 + n5 \quad 6 : + 8 6 m$ U@<du\\$>KY\$327dJ?=dUUX>K\$\JZ@72dd@10d/-dG;Q?eliOJ?Kd>?;Nd OU?d^;N\;72/?\dK_dUXM_?dd;^?sdU\$?Kd\$KZ?K';\N?dXKQ?\$K25Ydd VUY12/de2ZdJ??d6>?dC? = ZU**X**a7X67YV?Z=UZZduJ?_dUXNK>YddaC^?§a/d < UZJYdKQ\N;ZKSU>S1ddJaYK=Y;?NZdZKSIY d

 ~ 0 . OO o(); et U \ S > KY solid Y V ? = K 2@ Ja? NotU Z ? S Z UK C NY 67 Z d ZJ; Z=d S d? dN N U ? *KaZ Xa2 Y V ? Z= UZadu ? of C ? C + O J Y dA. Experiment in Simulation @UX.dd K - - OdVN;SS?KXZYdcQVN?ZYJd??dS>?d@@? = XZUX.@Mad d OJ? EIX Y 7Z 'd/? X K Q ?KSYZdbU S 1K dSYdK Q \ N ; Z K UY 94K Yeld? Y = X K < ? > d / | ·₄O . OO | O_0?X?d | KYOArs?X;Z?≈add Ksø?=ZKU*Sd _d?d>?=UQVUY23kK1V2dYMKoSZ0@dU\W/d?ad Y; Q V N K & Uđ <du \ S > K & Vd = Bd VJ;Y?Y d IX;YZ/K25dludY?NoKHKSVodZJ?JdUY?Z&X;SYVUXZKSId

KI\X4² oYJU_Y;8id? ';Q.V.N.12ide?;dl 2 * d.J;S > bdX;Y.V.K.Sidd ZJ?.dlUY?2dU2J?.dla > X;S.Z.Sidx SY?X.Z.KZ.Si?ddUY?kdSZ12id?d = a N K S > XVK k∈V K1′65daZ J K kYxd;Y V 6/d ;SZ 72/U;dN N U;Sda dlX;Y V d J a > X;SZ K bl\X ? dK N N \YZ XZ;JZ?%b0%xdU = ?12/¥926du K Y? dV ? X K Q ? SZ d ZJ; ZKUYXUUZ; Z? XKU\SZCI?N; ZKUYXUZ; Z? XKU\SZCI?N; ZKUYXUX; N 02?; YZKUKX? = ZKU@256LU?VIKV?ZCUCIKV < ? elUSYK > ? K(\$27z4)d? dK - - OdVN;SS?6XJ&lY_02*cb?ES7zdl?dV?X@UX0x?a;xdmtKQ\N;Z72>ddXU<UX27a;kdmtKQ\N;Z72>ddXU<UX27dKS21zd?*dV?S- 4 d O/-d@X;Q.⊋ıd;Z.ofJ?boltXKIKUS@ofdJ?VolKV? addYV? = K@aKSIdYZKJO2?\dN;Z.U.X.d

Q; Z X K B di [0 0 0 , 000.0 0 0 - p ji i; Y d K SKd \ X42 d "S a J ? d? I K S K SZIJ ?0XdU < UKZY0KdS K Z K; N K U ?ady X ?>?ES?>d _ ? d N N U Z_dt?Jd;S > ZtUCd?? ? N Xt0l Z;Z Xt0l \ S ztdt?ad ; 'K YKdSZdJ ? d V U Y ? Xt0r/J U _ SKdS dK I \ X ? d ; OdJ ? 0/U Y ? 1/de2ZdJ ?Zd; < N 72 Jd? d 0 / - de X; Q ? d 0 J ? d X; S Y @ UUX@2ddl? dl / - de X; Q ? ld Y V ? = K E ? YJdU Y ? Z dl ? Jda > X; S ZS xd d J ? XdU < U; X d Cd; S \; N NVaXd? > ? E S R S d ZJ?VdUY?Ud@ZdJ?VdKV?_0KZJXd?YV? ≩ 12/20dJ?dUX N ⇒ blUX > KS;Z;35 dbfV?S- 4 d²S^KXUSQE?1Sj22dvlKSZ(d)?dK--OdVN;SS?Xd Y a Y Z ?;OS oF 61 ?? > XZ b1 < d? al ? Z ? X Q K \$X 53 ZaLdl?_dU X M Y V ; 2 17 Zdl ? X kd S Y K 3 17 @ S - 4 Zd 2; xk Q 6D U Z K U@ S kd X 61 ; = J K 5Z U@ 2d J ? dk Q ZJXU\I;bbbl?X=?VZK/bb/%Zl?02Xbbl;S\;NDd?;Y\X?Q?SZY_d_=;Sel?bl?S?X;Z?*Klo%X?d<;ds>d_et YdJU_YZdl?XdKIJ;ZXdQ.d